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CIS

COAL AS A CATALYST IN AMERICA'S REVITALIZATION

HEARING

BEFORE THE

JOINT ECONOMIC COMMITTEE
CONGRESS OF THE UNITED STATES

NINETY-SEVENTH CONGRESS

FIRST SESSION

JANUARY 13, 1982

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(Created pursuant to sec. 5(a) of Public Law 304, 79th Cong.)

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COAL AS A CATALYST IN AMERICA'S REVITALIZATION

WEDNESDAY, JANUARY 13, 1982

CONGRESS OF THE UNITED STATES,
JOINT ECONOMIC COMMITTEE,
Washington, D.C.

The committee met, pursuant to notice, at 10:05 a.m., in room 2128, Rayburn House Office Building, Hon. Henry S. Reuss (chairman of the committee) presiding.

Present: Representative Reuss.

Also present: James K. Galbraith, executive director; Louis C. Krauthoff II, assistant director; and Mark Bisnow and Chris Frenze, professional staff members.

OPENING STATEMENT OF REPRESENTATIVE REUSS, CHAIRMAN

Representative REUSS. Good morning.

The Joint Economic Committee will be in order for a hearing into ways and means of reindustralizing America.

The Joint Economic Committee, like everybody else, has been on the reindustralization kick for some time. We would love to be in a position to be able to delineate winners on the American industrial scene—semiconductors, computers, telecommunications, or whatever. But we've long since concluded that we aren't smart enough to do that. Probably nobody in Government is smart enough to do that.

By providing a decent economic environment, we can give new and particularly high technology industries the greatest chance of survival.

Equally, we aren't particularly enchanted with the idea of helping losers. There's been a good deal of that in automobiles, steel, and shipbuilding. And I'm not at all sure that the results changed very much what would have happened anyway.

We do, however, think that there is something useful to be done in trying to delineate in the field of industry, not necessarily winners or losers, but catalysts—those industries which, by going into high gear, may affect broad sectors of the economy and thus make for expanded jobs and growth.

For example, the committee thought it somewhat disgraceful that we alone of the industrialized democracies lack a decent passenger rail system. And patterning on some of the ideas of France and Japan particularly, we recommended that in some 20 heavily urbanized corridors it would be economical to encourage high-speed passenger rail in this country.

This morning we turn to coal, a subject which has been often visited by Congress, because we have it in the back of our minds that perhaps coal deserves recognition as a growth and catalyst industry.

We are fortunate in having a blue ribbon panel of witnesses: Prof. Carroll Wilson of MIT led the World Coal Study, which was an invaluable basis for our own research; Jan Mares, Assistant Secretary for Fossil Energy; Eugene Samples, chief executive officer of Consolidation Coal Co.; the Honorable Russell Train, now president of the World Wildlife Fund and former EPA Administrator; William Wearly, chairman of the executive committee of Ingersoll-Rand; John Hertog, senior vice president of the Burlington-Northern Railroad; and Allen Dorris, president of the Coalstream Pipeline Co.

I am going to ask Mr. Wilson to give us the benefit of his statement first.

Let me say at the start that all the witnesses have provided the committee with excellent and, in most cases, compendious prepared statements. All those statements are received without objection in the record.

And we'll now ask each of you, starting with Mr. Wilson, to proceed in whatever way you like, reading your statement or going beyond it.

After Mr. Wilson's statement, I shall have some questions to put to him. Then we'll hear from the other witnesses as a panel, and withhold questions until all have been heard.

Mr. Wilson, we're honored to have you with us this morning. We want to express our gratitude again for your trailblazing work in so many fields, notably this morning in coal.

And will you tell us whether you think that coal is indeed the kind of catalyst for America's reindustrialization that we have in the back of our minds it may be—if so, how we get from here to there?

STATEMENT OF CARROLL L. WILSON, PROFESSOR EMERITUS, SCHOOL OF ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, AND PROJECT DIRECTOR, WORLD COAL STUDY

Mr. WILSON. Thank you, Mr. Chairman.

I think you have given a very good description of my concept of coal, both as a growth industry and as a catalyst for the reindustrialization of America, which I believe is the focus of this series of hearings.

My interest in the subject, in part, grows out of the previous energy study, the Workshop on Alternative Energy Strategies, which ran from 1974 to 1977 and engaged people from 15 countries around the world.

FINDINGS OF 1977 ENERGY STUDY

In that study we attempted to make estimates of the projected demand and the supply of energy. The central conclusion was that oil, which had met most of the increased energy needs over the past 20 years, was likely to level off in total world production, maybe in the early 1980's, largely because of decisions by key producers to stretch out their reserves. This was considered a very pessimistic view 5 years ago, but events have confirmed that, in fact, it was rather optimistic.

We also concluded that only two fuels were sufficiently developed, had technology available for use on a large enough scale to be alternatives and to meet future energy growth needs in view of the leveling off

of world oil availability. They were nuclear and coal, which are more or less interchangeable, as you know, for generating electricity.

I had serious doubts myself that the nuclear picture would improve very rapidly. I had, in fact, been the first general manager of the Atomic Energy Commission many years ago, back in the late 1940's, and had followed the field closely since then.

Therefore, it seemed to me useful to bring together some people who would look at world coal demands and sources of supplies to meet such demands.

So, in 1978 I brought together about 80 people from 16 countries who worked together to estimate global coal supply and demand and world coal trade. The result was the study "Coal, Bridge to the Future," to which you have referred. Our report was published in May 1980, and since then has been translated into a number of other languages, including two Chinese editions, one in Peking and one in Taiwan.

The people who were involved in the study came from 16 countries which use three-quarters of the world's energy and produce and use 60 percent of the world's coal.

DESCRIPTION OF MAIN CONCLUSIONS

In the remarks I make today I will give you a very brief summary of our conclusions, and I will speak principally to the figures which are attached to my prepared statement. And if you look at those, I think I can walk you through them and describe what the main conclusions are.

On figure 1 is the list of the countries whose people took part in the study. Up in the right-hand corner is an indication that these countries consume three-quarters of the world's energy, so they were fairly representative.

Figure 2 is our estimate of world oil imports' projections. I mentioned that we had concluded in the previous study that world oil production was likely to level off maybe in the early 1980's and that increased energy growth would have to be met from other sources.

This diagram is the result of our many discussions. We said, "Suppose OPEC production continues at 30 million barrels a day over this period, how much might be available for import by OECD countries?"

OPEC use will increase because of the large projects they have for using energy. Non-OECD imports might increase—in fact, some might be from the Soviet Union. We know there's been a lot of discussion as to whether the Soviet Union might be entering the oil import market.

So, we concluded that the OECD countries should not count on more than 22 million barrels a day. Actually, the current figure is below that level.

The next figure, on the right-hand side—you'll see "what happened on the way to the forum"—between the beginning of the World Coal Study and our completion.

You will observe what happened to world crude oil prices. We started our work in October 1978, and oil was then about $14 a barrel. When we finished, it was close to $35 a barrel. So a dramatic change had occurred in the economic framework in which energy is used, including coal; $35 a barrel oil is about $165-a-ton coal equivalent.

We gave great attention to environmental effects of the use of coal, and I'd like to say something more about that later. We turned to each

of our country teams and said: "What are your environmental standards, and how much does it cost in additional cost per ton of coal to meet those standards?"

STRINGENT STANDARDS IN JAPAN

We found that our Japanese team had the most stringent standards in the world. They estimated, as you'll see from that control cost bar, that it would add $35 a ton to the cost of using coal to meet their standards for control of SO_x, NO_x particulates and a lot of other things they could see ahead, including covered coal storage and $4 a ton per ton of coal burned to pay for removal of ash. If you add the $35 to the $45, which was their import cost for coal, it amounts to $80 a ton, or $17 a barrel, oil equivalent. This is about half the $165 a ton of coal equivalent which is the competitive price for oil.

So a great change occurred between the time we began and the time we finished which favored the economics of coal use.

The very impact and conclusion from this is that even applying the environmental control costs in the most stringent country in the world, coal ends up, in cost per ton burned, one-half of the cost of oil.

The next figure, 4, was made by adding up the projections of each of our 16-country teams and our estimates for the rest of the world. Figure 4 reflects that picture and also shows the 1960 to 1977 period.

The OECD accounts for a substantial fraction, somewhat more than half of the total energy consumption in the world. You can see in the OECD countries, which are the industrialized countries, oil use and oil imports met most of the increase in energy demand in the period from 1960–77.

With an expected decline in oil availability over the period to the year 2000 coal use will have to double from 1977 to 1990—that's from 1 to 2 billion tons—and nearly treble by the year 2000 to 3 billion tons, 3,000 million tons.

This is our projection of future energy mix and the changed role of coal in the energy mix of the world.

The next figure, No. 5, puts together our estimates for our various countries. These are the OECD estimates. You can see, from 1960 to 1977, energy growth rates and GNP were about the same, a little over 4 percent per year. In our projection over the period from 1977 to 2000 improved energy efficiency should allow a GNP growth rate of 3 percent to be met by a 1.8-percent energy growth rate.

Coal is the next bar, at 2,800 million tons, then nuclear, hydro, solar—gas a little larger, and oil a little smaller.

Please take note that energy, which is largely fossil fuel, from 1960 to 1977 was growing at a little over 4 percent. Our estimate is that demand for energy will grow at less than 2 percent over the next 20 years.

This is shown in a little different way on figure 6. You can see coal must meet 60 percent of future energy increases in this period, 1978 to 2000. Oil decreases 10 percent. Natural gas is up 10 percent. Hydro solar, 13 percent.

The bars for nuclear and coal are two different heights. We had a range for nuclear. We concluded that if nuclear rose sixfold between 1980 and 2000, it could provide 32 percent of the energy growth rate and coal 55 percent. However, we considered a sixfold growth very ambitious. We believed that a fourfold increase in nuclear over the

next 20 years was more realistic, in which case nuclear would provide 20 percent of increased energy needs, and coal would have to provide 67 percent.

As you know, most of the coal is consumed now in the countries in which it is mined. Most of the coal moving in international trade has been metallurgical coal. But you will see from figure 7 our estimate of future world coal trade, in which you'll see that we don't expect metallurgical coal to go up very rapidly, but we do expect a very large increase in steam coal imports by Western Europe, by Japan, and by the Pacific rim countries. In these industrialized regions there are many countries which will have need for energy but which do not have significant domestic coal production.

So the big growth we see ahead is in the steam-coal imports or the steam-coal trade, growing fivefold to sevenfold over the next 20 years.

MAJOR EXPORTERS OF COAL

Figure 8 shows where this coal might come from. Here are shown the producers who could export such amounts of coal.

We had in our study United States, Australia, Canada, People's Republic of China, and Poland. We made estimates for the U.S.S.R. and for the rest of the world. We had very helpful information from South Africa, which was not a member of the study.

With substantial expansions in the export capacities in each of these countries, the import demands could be met. Canada, at 67 million tons would be about a fivefold increase over existing export levels. South Africa's expansion would be about fourfold, at 100 million tons. Australia, at 200 million tons would need to expand at least fivefold. The United States, at 350 million tons has to expand sixfold over the level in 1978 which was about 60 million tons.

You will assume overestimates from the People's Republic of China, Poland, and Russia. We had a Chinese team from the People's Republic of China with whom we had an interesting dialog as to what they thought they could export in the year 2000. We settled for 30 million tons a year. It could be larger.

Poland—50 million tons a year. As you know, Poland's coal production and coal exports have fallen substantially under the present conditions, but 50 million was as high as they thought they believed they could go by 2000.

We estimated 50 million tons for the U.S.S.R., and 80 for the rest of the world. We had a good deal of knowledge among our members as to world prospects. You can see that the United States becomes the "swing" producer.

Suppose the United States exported 350 million tons of coal a year—figure 9—and using a price of $35 a ton, which is well below the FOB level today, exporting 350 million tons would earn us $12 billion. At $50 a ton, we could earn about $17 billion.

Coal could become one of our major sources of import earnings.

Export of 350 million tons by the year 2000 would, we estimate, amount to about 20 percent of U.S. coal production at that time.

The final figure, figure 10, puts these estimates together. It essentially shows here the sources at the right, and here's the projected demand for coal imports. You can see that the United States is, indeed, the swing exporter. If the lower level is 220 million tons of exports from the United States. The upper would be 420 million tons.

In conclusion, I'd like to comment on the question that is central, I think, in your hearings, Mr. Chairman, which is, What can Government and industry do together? We had a number of large coal importers, or potential coal importers in our group. They look favorably toward the United States but they worry about such things as unrestrained rail charges to ports and long delays in dredging ports to serve the large coal carriers which are economical on long coal trade routes. Action by the Government can reduce such worries and obstacles to larger coal exports, first as to inland transport.

The competition of coal slurry pipelines and enlarged river transport systems through locks and dredging of harbors constitute the best assurance that rail rates will be related to costs. With expanded use of coal, railroads will have plenty of business even if the pipeline and barge transport grow substantially.

Congress can make substantial contributions to this enhanced competitive position of U.S. coal exports by passing legislation allowing coal slurry pipelines rights of eminent domain such as all other interstate energy carriers have. Also, Congress can act on the measures which I understand are being put forward by the House Committee on Merchant Marine and Fisheries to shorten and simplify the permit procedures for port expansion and dredging and to overcome bottlenecks on the Ohio and lower Mississippi.

We have an exceptional opportunity to assist our trading partners abroad to use low cost coal and to expand our coal export earnings to levels in a few years which might match the cost of oil imports. It takes a partnership of public and private sectors to do the job which will contribute in this way to the revitalization of America.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Wilson, together with an attachment, follows:]

Prepared Statement of Carroll L. Wilson

Thank you, Mr. Chairman.

I appreciate the opportunity to appear here today. My main purpose is to describe a basis for estimating world coal demand, and world coal trade.

My interest in this subject arose, in part, because from 1974 to 1977 I organized and led a study of global energy estimates for the world. It involved people from 15 countries, about 80 people altogether, who held a number of meetings to try to estimate global energy demand for 1985, 1990 and 2000, and estimates of the supplies of different fuels.

The report of that group called the Workshop on Alternative Energy Strategies was issued in May of 1977. Its central conclusion was that oil, which had met most of the increased energy needs over the past 20 years, was likely to level off in total world production, maybe in the early eighties, largely because of decisions by key producers to stretch out their

reserves. This was considered a very pessimistic view four years ago; events since then have confirmed that it was in fact rather optimistic.

We also concluded that only two fuels were sufficiently developed, the technology available, and use on large enough scale to be alternates to meet future energy growth needs, in view of a leveling off of world oil availability. They were nuclear and coal, which are more or less interchangeable, as you know, for generating electricity.

I had serious doubts that the nuclear picture would change very rapidly. I had, in fact, been the first General Manager of the Atomic Energy Commission, many years ago, back in the late forties, and had followed the field closely since then.

Therefore, it seemed to me useful to bring together some people who would look at world coal demands, and the sources of world coal supplies, to meet such demand.

So in 1978, I brought together about 80 people from 16 countries, who worked together to estimate global coal supply and demand, and world coal trade. The result of that study was a report called Coal - Bridge to the Future, published in May of 1980, and since translated into a number of other languages. This was the composite work of teams from

16 countries, which use three-quarters of the world's energy, and produce and use 60 percent of the world's coal.

In my remarks today, which are aimed at giving you a very brief summary of the conclusions of this study, I will be referring to some visuals which are in your folders. My remarks are addressed to these diagrams.

Figure 1 shows the 16 countries from which the participants in the World Coal Study came. These countries use three-quarters of the world's energy, and they produce and use 60 percent of the world's coal.

Figure 2 shows our estimate of oil available for import. Reduced amounts available means greater demand for other fuels, such as coal and nuclear. Figure 2 shows our conclusion that even if OPEC production continued at 30 million barrels a day through the next 20 years, increased OPEC use would reduce the amounts available for importers. Moreover, non-OECD importers, who might include the Soviet Union, would take more, leaving no more than 22 million barrels a day to count on. This has major energy implications for the energy balance and demand for coal.

If you look at Figure 3 on the right-hand side, you will see what happened to oil prices between the time we started the coal study, in late 1978, and the time we concluded it.

Oil was about $14 a barrel when we began, it was $35 a barrel when we finished. That is $165 a ton coal equivalent.

So the market and opportunities for coal improved vastly over that year and a half, because if the competitive fuel is $165 a ton coal equivalent, it leaves a lot more room for environmental clean up and the like. You will see at the left on Figure 3 our estimates of how much it would cost to apply in Japan where they have the strictest environmental rules in the world. Our Japanese team estimated that it would add $35 a ton to the cost of burning coal. Coal could then be imported into Japan for $45 a ton - that totals $80 a ton, or half the price of the equivalent amount of oil while observing the most stringent environmental standards in the world. This three or fourfold differential in price between oil and coal we estimated would continue.

If you look next at Figure 4, you will see that from 1960 to 1977 most of the increased energy needs of the world were met by oil, mostly oil imports. We estimated that the use of oil would decline over the next 20 years, and therefore, in order to meet energy needs, coal use would have to double by 1990, and about triple by the year 2000, that is, from 1 billion tons in 1977 to 2 billion in 1990 and nearly 3 billion in 2000.

Figure 5 shows our estimate of the fuel mix in the year 2000. At the top you will see the amount from conservation - equivalent to about two and a half billion tons of coal. Next below is coal at 2,800 million tons, then nuclear and gas with oil declining. An important observation is that conservation (energy efficiency improvements) will allow a three percent GNP growth rate, with only a 1.8 percent energy growth rate (ratio 0.6) as indicated at the top of Figure 5.

The next diagram, Figure 6, shows the role that coal will have to provide over the next 20 years. Up to two-thirds of the additional energy needed by the OECD countries must be met by coal.

Figure 7 shows the estimate of coal import needs which mean opportunities for exporters such as the U.S. Our projection is that metallurgical coal will grow slowly over this 20 years, but steam coal import estimates, again, built up country by country, will increase from about 50 million tons a year in 1977 to 500 to 700 million tons in the year 2000.

We then looked at possible sources for coal imports on such a large scale. Figure 8 shows estimated sources. You will recall that we had members of the study from the United States, Australia, Canada, PRC, and Poland. We did not have South Africa, or the USSR. We estimated that only two countries,

Australia and the United States, probably could have enough capacity to export more than 100 million tons a year by the year 2000. Australia might be able to export 200 million tons, the United States up to 350 million tons or even more. In our projections of coal usage in the United States in the year 2000, 350 million tons for export would be about 20 percent of total U.S. coal production.

Figure 9 shows what the USA could earn in foreign exchange, if we exported 350 million tons at a very modest price of $35 a ton. FOB prices today are nearer $50/ton. Such prices would raise the total revenues to $17 billion per year. The opportunity is there for the United States to become the major coal exporter. In fact, we are already the largest exporter.

Figure 10 brings together our estimates of demand for coal imports and possible sources. Clearly the U.S. is the "swing exporter." If demand is there we could export 220 or 420 million tons and more.

Coal importers look favorably towards the United States but they worry about such things as unrestrained rail charges to ports and long delays in dredging ports to serve the large coal carriers which are economical on long trade routes. Action by the U.S. Government can reduce such worries and

obstacles to larger coal exports. Firstly, as to inland transport, the competition of coal slurry pipelines and enlarged river transport systems through locks and dredging constitute the best assurance that rail rates will be related to costs. With expanded use of coal railroads will have plenty of business even if pipeline and barge transport of coal grow substantially.

The Congress can make essential contributions to the enhanced competitive position of coal exports by passing legislation allowing coal slurry pipelines eminent domain for rights of way such as all other interstate energy carriers have. Also the Congress can act on the measures being put forward by the House Committee on Merchant Marine and Fisheries to shorten and simplify permit procedures for port expansion and dredging and to overcome bottlenecks on the Ohio and on the lower Mississippi.

We have an exceptional opportunity to assist our trading partners abroad to use low cost coal and to expand our coal export earnings to levels which in a few years could match the cost of oil imports. It takes a partnership of public and private sectors to do the job which will contribute "to the revitalization of America."

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FIGURE 1

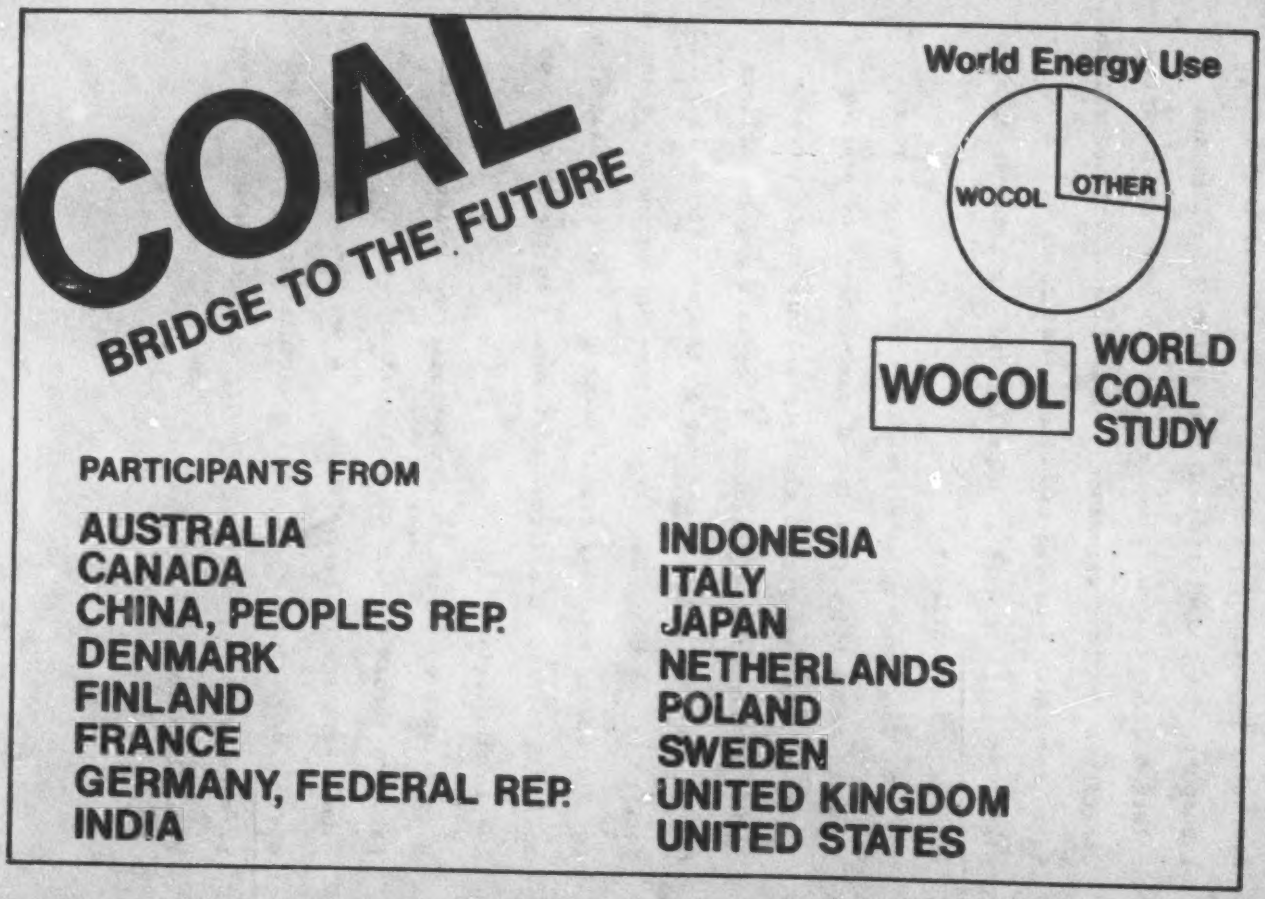

COAL
BRIDGE TO THE FUTURE
World Energy Use
WOCOL
OTHER
WOCOL
WORLD
COAL
STUDY
PARTICIPANTS FROM
AUSTRALIA
CANADA
CHINA, PEOPLES REP.
DENMARK
FINLAND
FRANCE
GERMANY, FEDERAL REP.
INDIA
INDONESIA
ITALY
JAPAN
NETHERLANDS
POLAND
SWEDEN
UNITED KINGDOM
UNITED STATES

FIGURE 2

WOCOL OIL IMPORTS PROJECTION

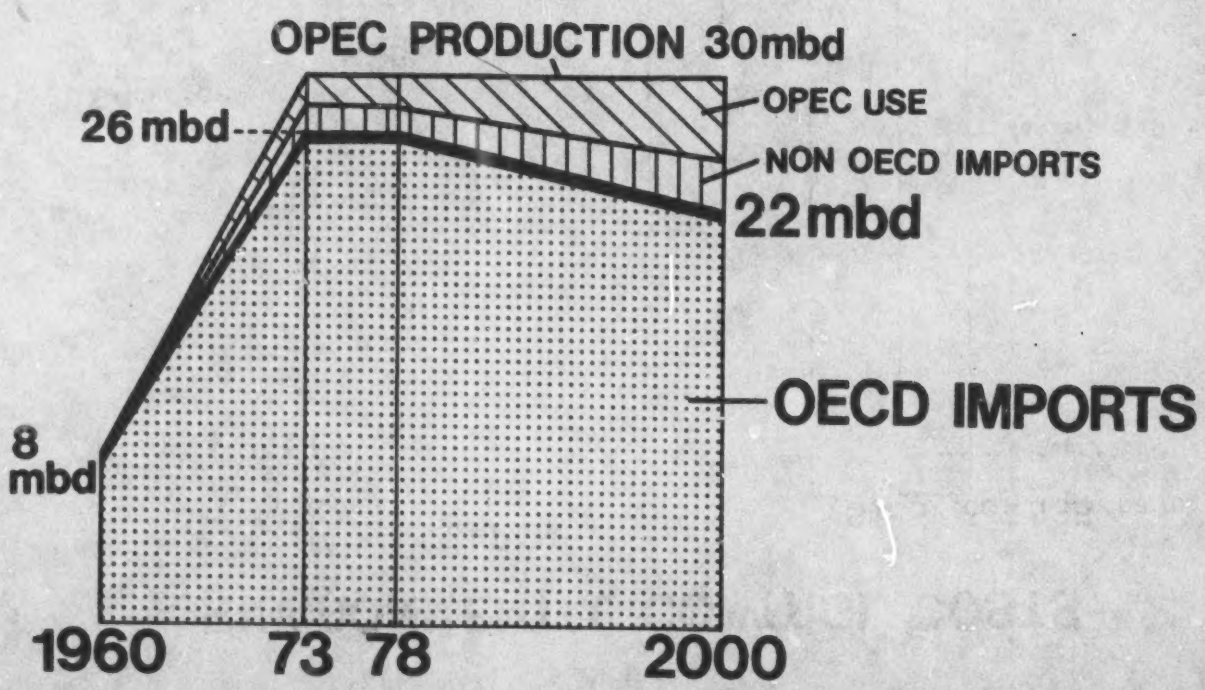


FIGURE 3

ENVIRONMENTAL CONTROL COSTS

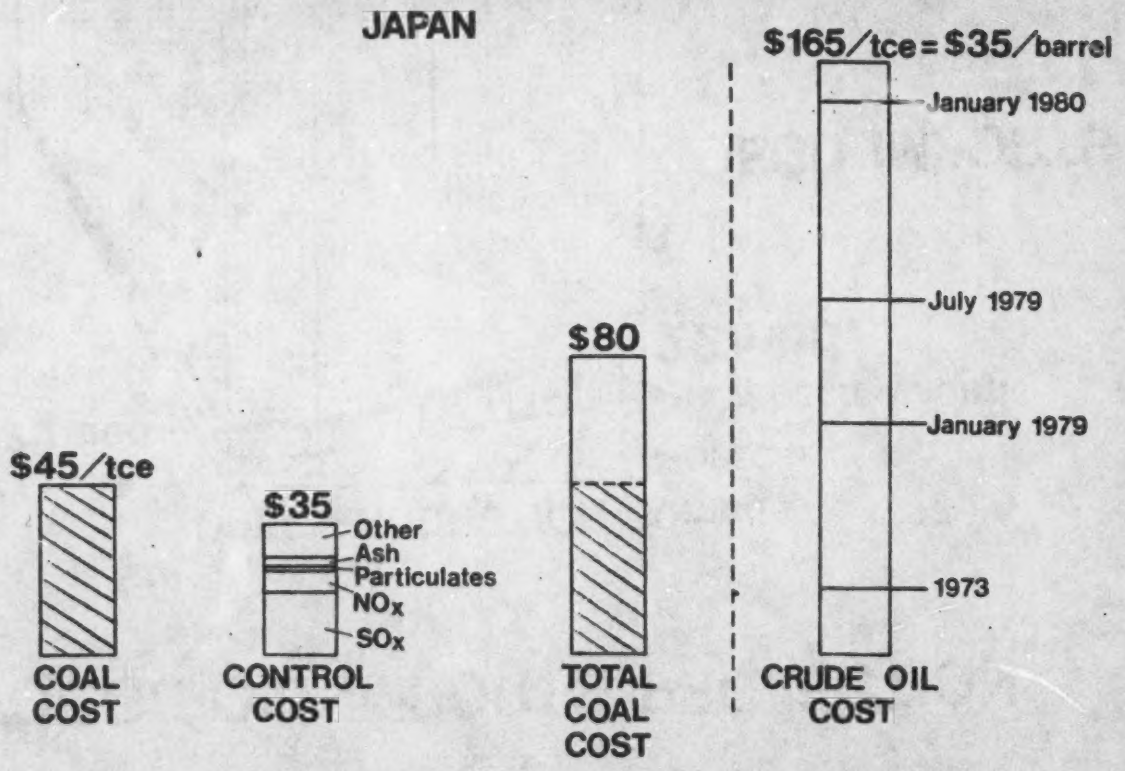


FIGURE 4

REQUIRED COAL EXPANSION

OECD

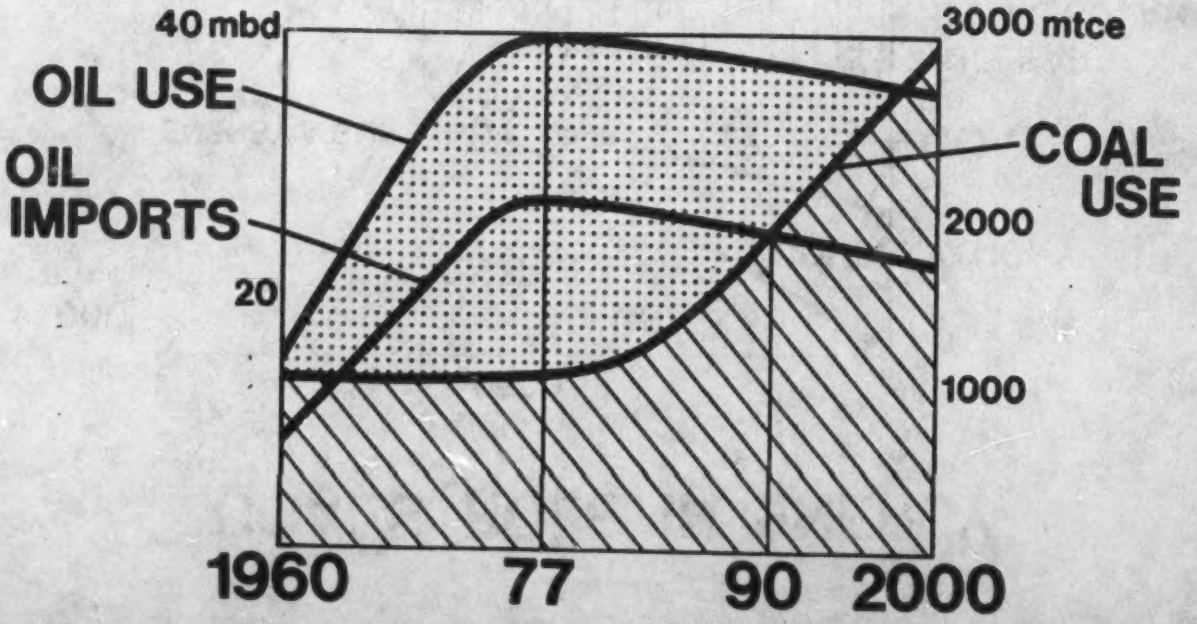


FIGURE 5

COAL'S ROLE IN ENERGY

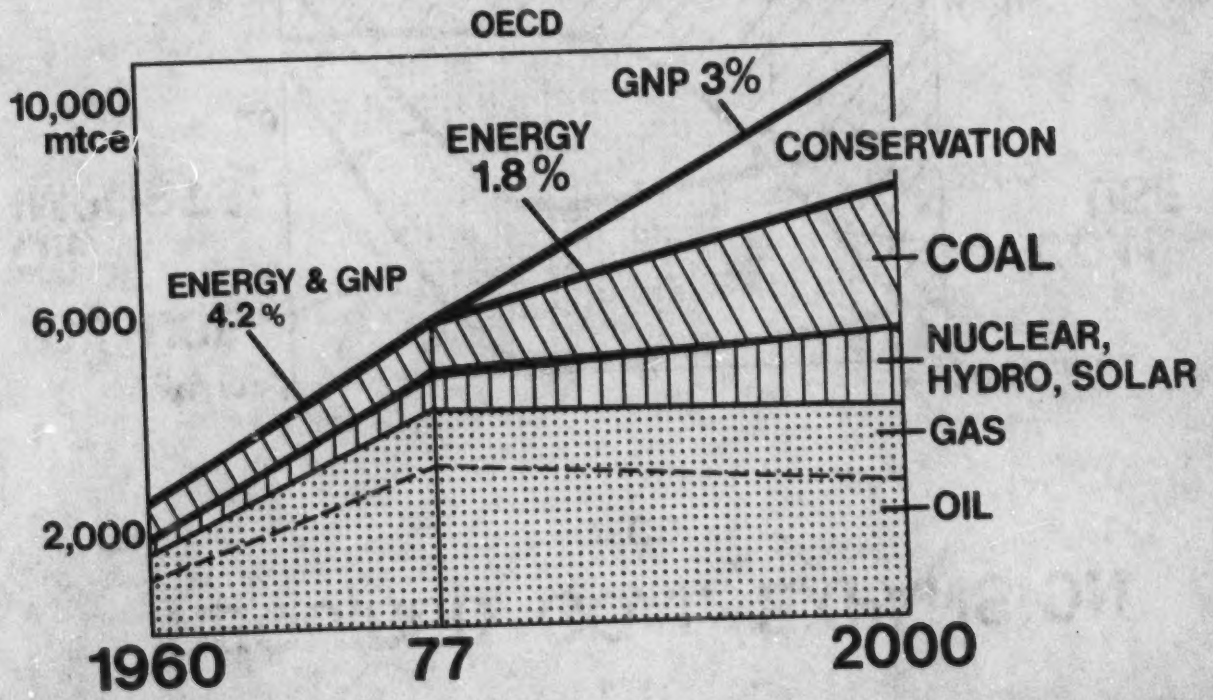


FIGURE 6

COAL'S SHARE OF FUTURE ENERGY INCREASE

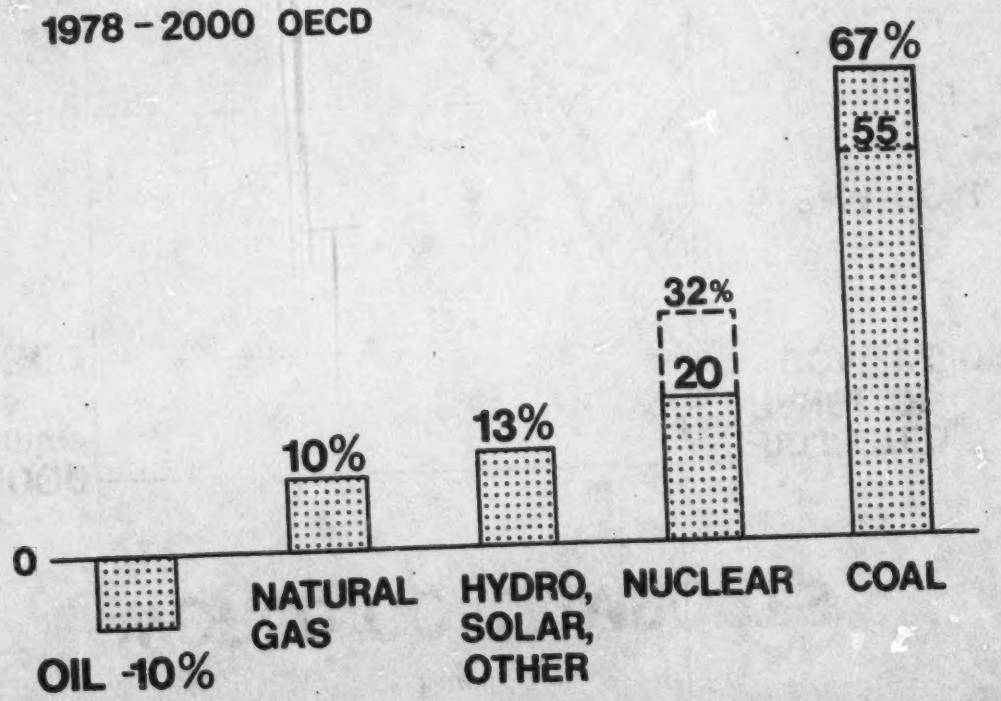


FIGURE 7

WORLD COAL IMPORTS

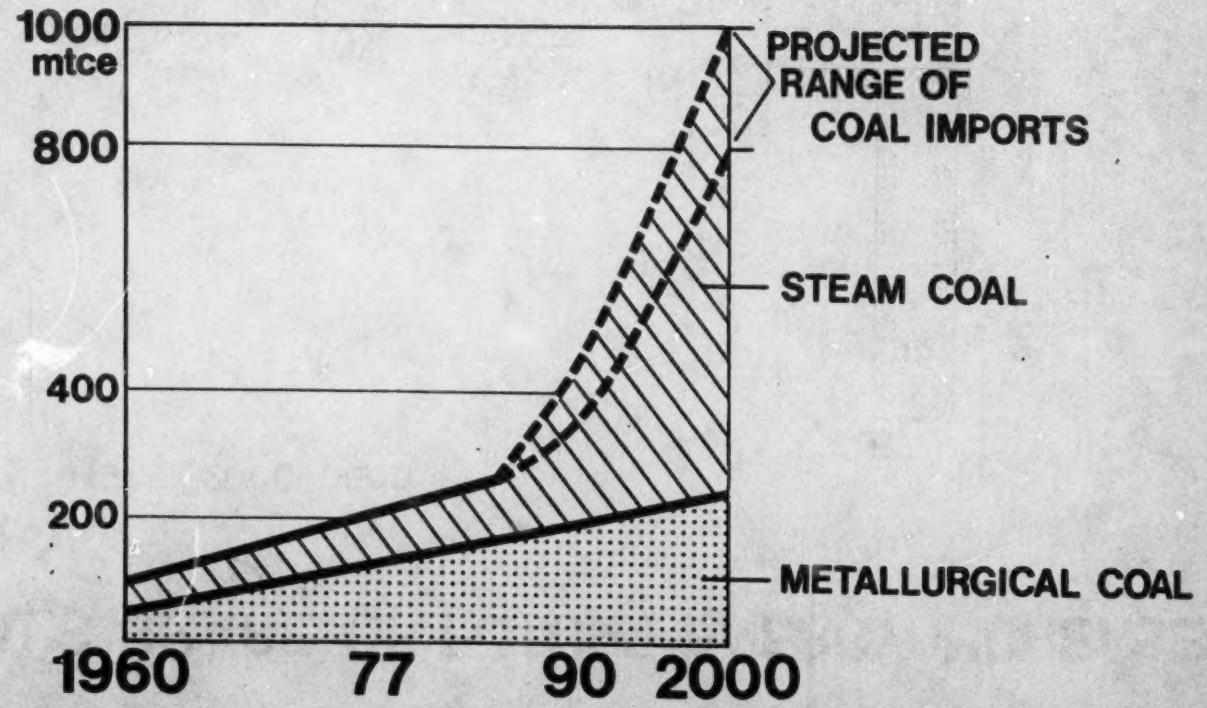


FIGURE 8

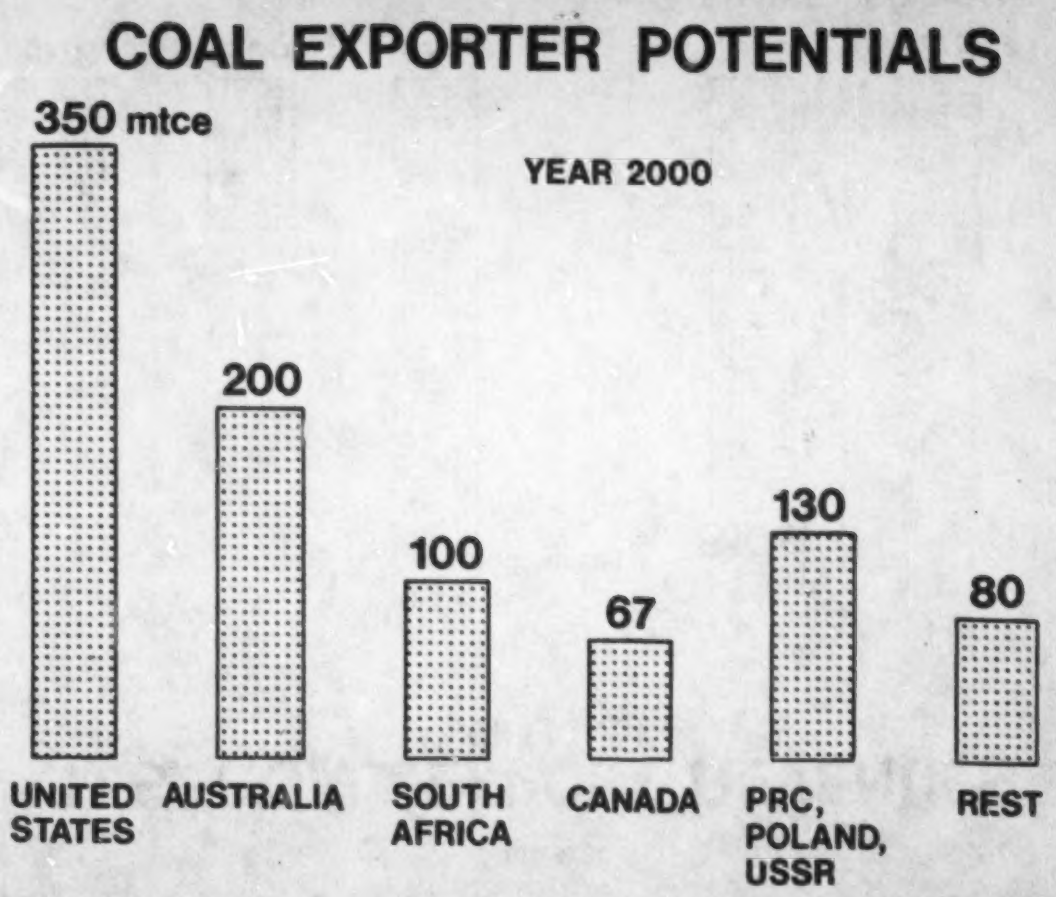

COAL EXPORTER POTENTIALS
350 mtce
YEAR 2000
200
100
67
130
80
UNITED STATES
AUSTRALIA
SOUTH AFRICA
CANADA
PRC, POLAND, USSR
REST

FIGURE 9

U.S. COAL EXPORT REVENUES
($ BILLIONS)

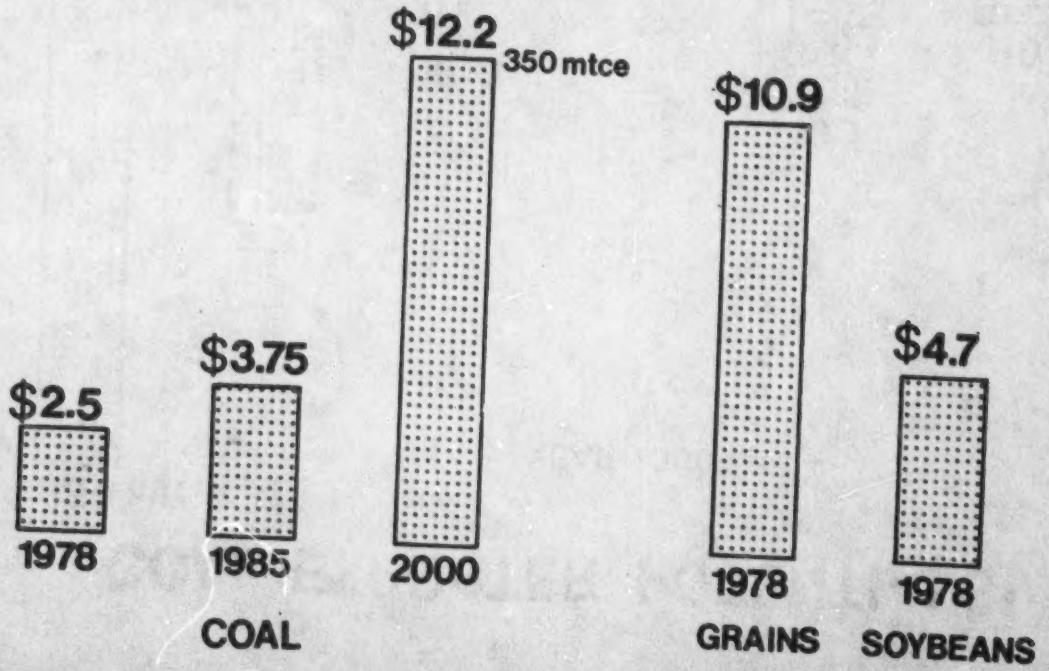
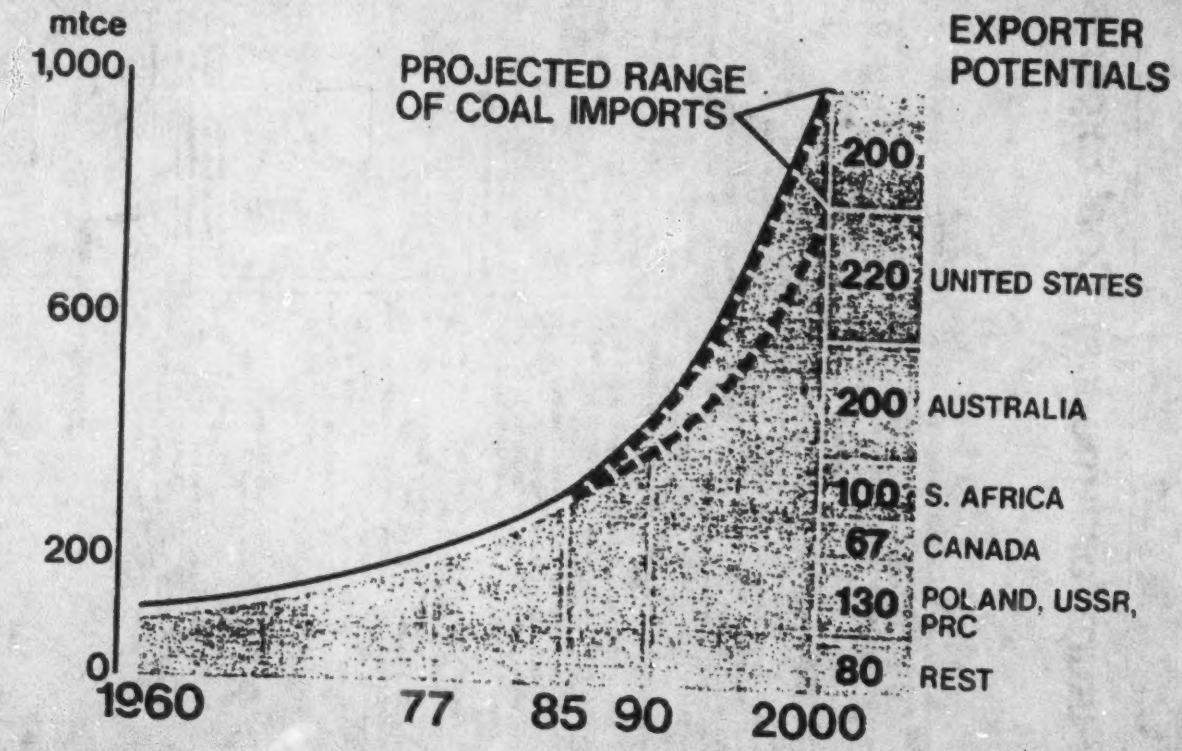


FIGURE 10

BALANCING COAL IMPORTS AND EXPORTS



by CARROLL L. WILSON
Project Director, World Coal Study, Massachusetts Institute of Technology

Future for American Coal Exports

Growth of world steam coal trade will depend principally upon demand from nations in Western Europe and East Asia which will need imported coal to meet increases in energy to support economic growth.

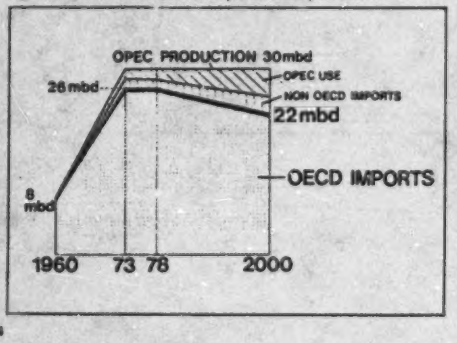
There can no longer be any doubt that the world has reached the end of an era in its energy history. Increasing supplies of oil imports, the basis for three decades of unparalleled economic growth, will not be available. Coupled with vigorous conservation and predictable increases in energy supplies from sources other than oil, coal can bridge the transition from the fading petroleum era to next century's energy systems. Coal is the only fuel capable of doing this in large enough quantities within the time available.

U.S., Australia can lead way out of energy dilemma

Even if OPEC nations continue to restrict oil output in order to stretch the life of their reserves and the current slowdown in the expansion of nuclear power continues, the coal-rich nations—spearheaded by the United States and Australia—can lead the way out of the present energy dilemma by tripling world coal production and expanding steam coal trade by 10 to 15 times.

This goal is attainable. It will require a 5 percent annual growth in the production of coal, which already provides a quarter of the world's energy—more than any other source except oil. But, it will require early commitments by coal users. Without unacceptable increases in cost, this additional coal can be mined, transported and used in most areas of the world in conformity with high standards of health, safety and environmental protection by applying available technology.

Fig. 1. Projection of Wocol oil imports to the year 2000



WOCOL countries use 60 percent of world coal

These carefully optimistic assessments are the conclusion of 38 persons holding key positions in governments and private and public institutions in 16 countries around the world. They were organized as the World Coal Study (WOCOL) which I directed, and they worked together intensively for 18 months. Their report, "COAL—Bridge to the Future," was released simultaneously around the world by WOCOL country teams on May 12–13, 1980. The WOCOL countries, which use and produce 60 percent of the world's coal and use 75 percent of the world's energy, are as follows:

Australia	Indonesia
Canada	Italy
China, Peoples Rep.	Japan
Denmark	Netherlands
Finland	Poland
France	Sweden
Germany, Federal Rep.	United Kingdom
India	United States

Fig. 2. The "oil shock" of January 1979 increased the cost of oil by 150 percent to about $35 per barrel (right). Cost of imported coal in Japan is about $80 per ton (left).

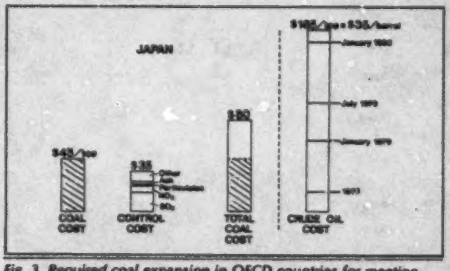
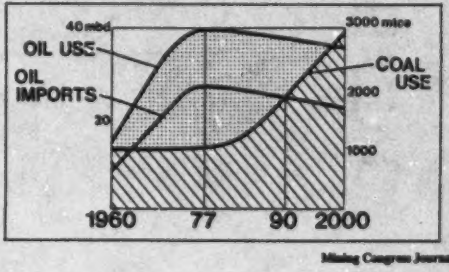


Fig. 3. Required coal expansion in OECD countries for meeting even moderate economic growth



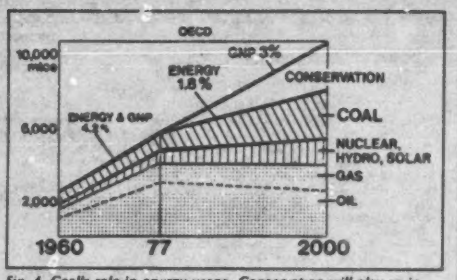


Fig. 4. Coal's role in energy usage. Conservation will play an increasingly important role in reducing energy demand in the years ahead

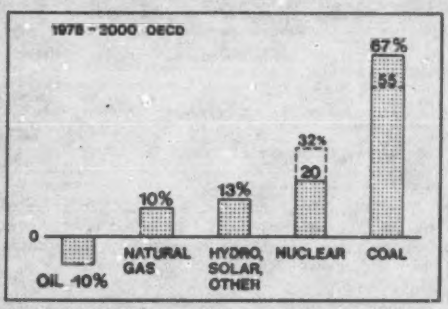


Fig. 5. Coal's share of future OECD energy needs will be governed by the growth in nuclear power consumption and may equa' as much as 67 percent

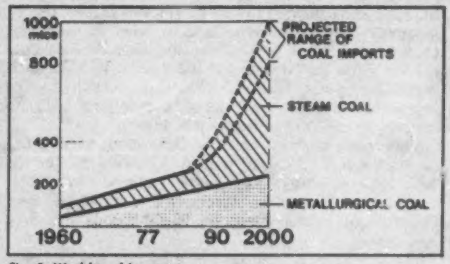


Fig. 6. World coal imports

Even if OPEC continues to produce 30 million bbl a day, the amount available for OECD (Organization for Economic Cooperation and Development) imports will decline. Thus oil, which provided two thirds of the energy increase in the period 1960–77, will provide less than zero in the decades ahead (see fig. 5). The risks are high that oil may contribute much less than zero.

The "second oil shock" has been the increase of 150 percent since January 1979 to about $35 per barrel or $165 per ton of coal equivalent, as depicted in fig. 2. Also shown is the cost of using coal in Japan and meeting their environmental standards, which are the strictest in the world and add $35 per ton to the $45 per ton cost of imported coal for a total of $80 per ton (or $17 bbl oil equivalent or half the cost of crude oil). Meeting U.S. source performance standards might add $25 per ton. Residual oil, which historically averages 15 percent less than crude and periodically as much as 50 percent less on the spot market, will become scarcer and more expensive as refiners turn more of the barrel into lighter fractions. The significance of this "second oil shock" on the economics of coal has not yet been fully assessed.

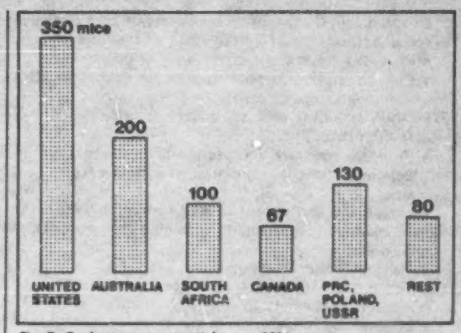


Fig. 7. Coal exporter potentials, year 2000

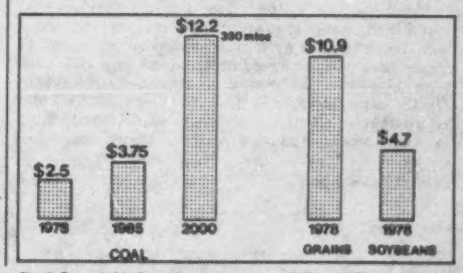


Fig. 8. Potential U.S. coal export revenues (billion dollars) with coal at $35 per ton FOB

Doubled coal use needed by 1990.

In the period 1960 to 1977, coal usage stood essentially still while oil met most of the increased need for energy (fig. 3). Combining the projections of our WOCOL teams for 1985, 1990 and 2000, we estimate that coal use must double by 1990 and triple by 2000 if even moderate economic growth is to be met.

Conservation should contribute 2.5 billion tons coal equivalent over the next two decades (fig. 4), with the energy to GNP ratio falling from 1.0 to 0.6.

The share of various fuels in meeting the 3 percent GNP growth include oil at less than zero (fig. 5). There are two levels of nuclear projections. A six-fold increase to 550 GW(e) would allow nuclear to meet 32 percent of the energy increase with coal providing 55 percent. However, if nuclear growth is slower, say fourfold, increasing to 400 GW(e), nuclear would furnish 20 percent and coal 67 percent.

Continued on p. 47

In summary, Conac offers many advantages over traditional methods for coal analyses. For example, it:

- Provides a nondestructive assay of coal.
- Can be applied to coal streams up to 30 tph, thus reducing sampling errors.
- Gives readouts that are timely enough for control system response.
- Provides accurate and precise analyses that are independent of coal type and, to a great extent, coal size.

Because the instrument is a *complete* analyzer, the Conac readout can be made available in a number of forms, e.g.,

- Percent sulfur by weight
- Percent moisture by weight
- Heating value, Btu/lb
- Percent by weight of constituent elements (and hence ash).

Finally, although Conac employs relatively sophisticated instrumentation, the instrumentation and output would not be seen by a process or plant operator. Instead, the operator would be provided only with basic data such as weight percent of significant constituents. On the other hand, it is because of this sophisticated instrumentation that Conac lends itself to ready interface with process and plant control systems. This would allow Conac data to be further processed and the operator to be provided with timely directions for proper process or plant operations. ◆

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[8]Rasmussen, N. C. "The Potential of Prompt Activation Analysis in Industrial Processing", *Analysis Instrumentation*, Vol. 7, (1969), available from Instrument Society of America. Presented at the 15th AID symposium.

[9]Gozani, T., G. Reynolds, H. Bozorgmanesh, et al., "Nuclear Assay of Coal," Vol. 1 through 8. EPRI Report FP989, RP983-1, January 1979.

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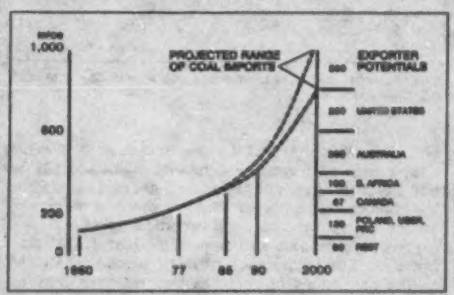

Fig. 9. Balancing coal imports and exports

Import demand seen above 800 million tons

World coal imports of steam coal are viewed by the WOCOL study as growing from 50 million ton to 500 to 700 mtce by 2000. The report also has projections by each WOCOL team of their estimates of needed coal imports in their countries in 1985, 1990 and 2000.

Our estimate of coal exporter potentials (to meet import demands by 2000 in the 800 million to 1000 million ton range) shows only two countries—Australia and the U.S.—with a potential of more than 100 million tons (fig. 7). The figures for Australia, Canada and South Africa all represent four to five-fold increases over present capacity. The 350 mtce for the U.S. would represent a seven-fold increase and would be about 20 percent of estimated U.S. production by 2000.

An indication of potential export revenues from coal (with coal at $35 per ton FOB) is suggested in fig. 8. It is clear from fig. 9 that the swing exporter is the U.S.A.

The WOCOL estimates it will take 1000 ships of 100,000 dwt each to move a billion tons of coal over long trade routes. A rapidly increasing fraction of these ships will be coal-fired.

Big challenge ahead for U.S. industry

Will the U.S. meet a demand for 350 mtce of coal exports? It would require 12 ports handling 30 million ton each and equipped to service ships of 150,000 dwt or larger. We have no such ports today whereas Australia, Canada and South Africa already have modern coal loading ports for large ships. We'll need 10 to 12 such ports along East, Gulf and West coasts with interior transport to bring the volume of 10 unit trains a day to support 30 million ton per year volume.

This is the kind of challenge American industry has met in the past. Securing permits for ports may be the most difficult part of all. Maybe quite new concepts, such as coal storage yards some miles inland and conveyor or coarse slurry lines loading ships offshore, may be needed.

It will take a cooperative effort by industry and government. A major question is whether there is in either industry or government the kind of leadership which can bring about such a cooperative effort.

Carroll L. Wilson was appointed the first general manager of the U.S. Atomic Energy Commission in 1947 and later held senior management positions with several companies involved in uranium mining and nuclear fuels fabrication. Since 1959 he has taught at Massachusetts Institute of Technology and is currently Mitsui Professor in Problems of Contemporary Technology. Wilson was director of the World Coal Study and earlier directed the Workshop on Alternate Energy Strategies.

DO EUROPEANS WANT U.S. COAL?

Representative REUSS. Thank you, Mr. Wilson. You've just testified that coal importers would like to become long-term contractual importers of our coal but they are concerned about such things as unrestrained rail charges and delays in dredging ports and so on.

Is it a fact that particularly the European countries have not signed up in any large measure as importers of American coal?

Mr. WILSON. I think some of my colleagues here are more currently informed as to the state of imports in the year 1981. For example, I think we exported over 100 million tons of coal in 1981 compared with 92 million in 1980 and 60 million back in 1976.

The breakdown of this as between Japanese imports and European, I'm not familiar with. I do know from scanning the interesting journals about bulk trade that a lot is going on in expanding the import capacity of coal terminals in Western Europe, particularly terminals to handle large vessels of 150,000 tons and upward. But the actual breakdown, and how that trade has developed in 1981, I don't know.

Representative REUSS. I would have thought, though, that OECD countries would have been eager to sign up for coal, American coal, on a long-term basis, as a means of getting us off our dime on things like slurry pipelines and port dredging and so on. That hasn't happened?

Mr. SAMPLES. Mr. Chairman, I'm Gene Samples with the Consolidation Coal Co. I might respond a little to your question.

There is considerable dialog going on between coal producers and world coal importers at this time and some contracts have been signed. To give you an idea of what's happening in the coal exporting scene, the United States and Canada exported overseas some 50-odd million tons of coal annually for the decade of the seventies that primarily went into the metallurgical coal market.

Now, about 2 years ago I think we were exporting 2 million annual tons of steam coal abroad. Steam coal exports increased to about 31 million tons last year. So, that's quite a growth in a 2-year period of time. It would have been more than that had the ships been able to be loaded. They sat out there in the bay in great quantities and just didn't get in to be loaded.

So, the growth that Mr. Wilson has described has started with a bang. I'm not sure how it will be sustained into the future. We're very hopeful that it will be.

IMPORTANCE OF LONG-TERM CONTRACTS

But, if it is sustained we've got to clear up the chicken and egg situation in which the importers have said: "Well, we want some idea that we have sanctity of contract. In other words, when we sign a contract with the United States it's going to remain in place and we'd like to have an expression, from your government, that indicates that is the case."

I think this is not a great concern now because this still is the most stable place in the world and will be forever, I hope. So, I'm not concerned about that. But they said, "We're not going to put our ships out here and wait forever and pay demurrage costs that are equal to the cost of the coal when we can take it to South Africa and go to Australia or someplace else, pay higher freight charges and still have less costs delivered."

A delegation was in my office 2 days ago on Monday, a foreign delegation, very concerned about freight rate increases and what it was doing to their delivered cost of coal. They were soliciting our help to allay or to stop unrestrained freight rate increases to exporters.

So, freight rate increases are very troublesome to us, to those of us who have to market our product, and I think Mr. Wilson was very accurate in his assessment of this problem.

Representative REUSS. Mr. Wilson, your world coal study came out in 1979 or 1980 when the full effects of the second oil shock were being felt. Now those effects are somewhat attenuated, at least for the moment.

EFFECTS OF CURRENT OIL SURPLUS

Does the fact that oil is less scarce in the world markets than it was 2 years ago in any way invalidate the conclusions of your report which generally said that coal production and consumption is to treble in the next 18 years?

Mr. WILSON. Well, I think the price hasn't softened very much in the oil market. It's held pretty firm. And the $35 a barrel, approximately, is still $265-a-ton-coal equivalent.

So, the differential on a heat content basis between coal and oil is still anywhere from twofold to fourfold and the coal prices have gone up somewhat but not very much. So, that differential in price between oil and coal has largely remained. It was our estimate that because of the very large coal reserves, because of the profitability, if you will, of mining and selling coal at present price levels, that the differential between coal prices and oil prices would be sustained in the future.

I think it's primarily the driving factor of those differences which have made such an increase in coal consumption over these past 2 years. There has been a steady substitution of coal for oil, most notably in this country by the utility industry where use of oil has dropped by 700,000 barrels a day by substitution of coal for oil.

Representative REUSS. You in your statement urged that Congress pass legislation giving coal slurry pipelines the same eminent domain powers that other energy pipelines have seen. Does the administration have a position on such legislation?

Mr. WILSON. I don't know.

Mr. SAMPLES. Excuse me, sir, since it is so important——

HOW BAD IS "GREENHOUSE EFFECT"?

Representative REUSS. Well, I'll wait until your testimony, then. One of the great concerns about the United States adopting an all-out program of coal expansion has to do with certain environmental considerations of which, in my mind at least, the foremost and the most disturbing is the so-called greenhouse effect of carbon dioxide.

In your report on coal you devoted a number of pages to it, and ended up on page 150 saying that it may happen that some effects of CO_2 will become detectable on a regional and a global scale before the end of the century and will require a reassessment of world fossil use at that time.

Just recently, in the last few weeks, the American press has carried a number of somewhat alarmist accounts of the possible acceleration in CO_2 effects—some at a meeting of the American Association for the Advancement of Science and some elsewhere—the net of which is that

it may well be that since the industrial revolution and the widespread deforestation that has occurred, we have indeed been placing a very high level of CO_2 in the atmosphere—more than the oceans and other absorptive elements can absorb. And if we go on, we may be bringing about the horrors that the doomsayers envisage; namely, a breaking up of the West Antarctic ice field and the consequent flooding of Boston, New York, Philadelphia, and all the other cities of the coastal plain, the drying up of the rich farmlands of America and the Soviet Union and China, and other environmental effects which you and I would not like to be responsible for.

I ask you, therefore, really two questions: (1) Is there something to the heightened forecast of bad things ahead on the greenhouse effect; and (2) What device appeals to you as a method of continued monitoring so that if we do go ahead with an accelerated use of coal here in the Western world, we have a fail-safe point so that if trouble impends we can make other decisions?

Those other decisions might have to be very drastic ones, like, we aren't going to burn fossil fuels any more. And I don't know what the answer is, but certainly this prospect is worrisome and it involves life on Earth.

So, I'd welcome your views on it today, in a day when the number of scientists who see something serious down the road has certainly increased over the number in existence a few years ago.

Mr. WILSON. I'm glad to make some observations on that point, Mr. Chairman. The subject of climate, man's impact on the global climate, has been of interest to me for some years. In 1971 I organized and brought together the first comprehensive assessment of man's impact on climate in Stockholm, when 30 scientists from 14 countries joined together and we wrote and published 2 months later this report, "Inadvertent Climate Modification: A Report of the Study of Man's Impact on Climate."

There were a great many things unknown then. There are still a great many things unknown. We did outline a program of research and measurement which ought to be undertaken so that 10 years later, like now, we'd know a little more.

Now, there have been a number of studies in the interim and the problem of CO_2 buildup, the problem of the greenhouse effect, so called, is an important one and deserves a great deal of study and more resources applied to it than it has thus far.

I might say that when we undertook the world coal study I felt a rather special responsibility for our treatment of CO_2 because my colleagues in the climate business would be looking fairly closely at what we said. We devoted a chapter in this book to environment, health, and safety, in which we look at all of the environmental impacts of coal mining, transport, and use including the CO_2 effects, and we assess the state of knowledge, of technology, and the cost of doing something about it where you can.

The only place where you can't at any feasible cost, is in the CO_2 department. So I think—I still went back and read this chapter last night. I think it's about the best lay, nontechnical description of these matters that exists. And perhaps, Mr. Chairman, you might have your staff consider including those 23 pages in the record.

Representative REUSS. We intended to do that.

[The information referred to follows:]

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CHAPTER 4

ENVIRONMENT, HEALTH, AND SAFETY

Reasons for Environmental Concern — Surface Mining — Underground Mining — Occupational Health and Safety — Coal Preparation and Cleaning — Coal Transport and Storage — Coal Combustion — National Air Quality Standards — Emission Limitations and Strategies — CO_2 and Climate Change — Solid Waste — Thermal Emissions — Land and Water Use — Costs of Pollution Control for Utilities — Coal Use in Industries Other Than Utilities — New Coal Conversion Technologies — The Need for Research

The large expansion of world coal production and use projected by the World Coal Study to the year 2000 means that each country will need to consider the resulting environmental, health, and safety issues. There is extensive experience with the mining, transportation, and use of coal and the application of environmental controls in the countries represented in this Study.[1] The major problems and issues to be considered in establishing environmental policies, standards, and laws have been identified. Research conducted over the last decade has improved the state of knowledge about both the issues and the control strategies and technologies available. By 1979 many countries had adopted detailed legislative and regulatory systems, or other less formal systems, for controlling the environmental, health, and safety effects accompanying increased coal production and use.

Reasons for Environmental Concern

Uncertainties remain about some issues. For example, the

[1] In WOCOL Final Report Volume 2, *Future Coal Prospects: Country and Regional Assessments*, each of the WOCOL country teams describes the specific environmental, health, and safety standards now in effect in its country and provides indicative cost estimates for meeting these standards.

magnitude of long-term health effects of some of the emissions from coal combustion; the effects of fossil fuel combustion on global climate; and the environmental, health, and safety hazards posed by synthetic fuel plants have not yet been determined. There are tradeoffs that must be made in each country among the degree of control, the resource and financial costs associated with that degree of control, and the benefits from using coal. Comparisons must also be made between coal and other energy alternatives that have environmental, health, and safety effects of their own. Although uncertainties make it difficult at this time to make universally accepted statements on environmental issues, four general observations can be made.

1. Most of the environmental risks from coal use are amenable to technological control. Emission release, noise, and other effects can be reduced to whatever level is required by applying currently available technology. Each increment of reduction increases the cost, and as one approaches total control, such costs become very large. Within what can be expected as standards we believe that coal can be produced, transported, and used cleanly at costs that leave coal competitive with other fuels. It is likely that environmental concerns or control costs will preclude the development of certain sites or certain coal resources. However, there are so many possible sites and resources remaining worldwide that such exclusions will not be a limiting factor to the expansion of coal use.

2. National perceptions of values differ on such things as exposure of the general public to health risks or visibility reduction in the atmosphere. For example, controversy continues on the extent of health effects from various emissions from coal combustion. Moreover, environmental impacts differ because of regional characteristics such as meteorology, topography, population density, and resource distribution. For such reasons, nations and regions take different positions on the kind and extent of environmental control measures they will require as coal use increases. Even though views differ widely, the countries in the World Coal Study plan large expansions of coal use and expect to apply measures that will ensure compliance with their national environmental standards.

3. There are some issues on which joint action among nations may be needed. Adequate mechanisms may not now exist for implementing international cooperation, although there are some precedents in the use of ocean resources and in the programs of OECD nations

on environmental matters. Agreement on the application of existing control technology for the interest of other nations in excess of what one nation might do solely on its own interest may be difficult but necessary. For example, the long-range transport of emissions and deposition of acid rain in several countries is receiving increased attention and may require early action. Similarly, improved understanding of the effects of pollutants requires continuing international cooperation. The need to integrate and coordinate some environmental actions at global, regional, national, and local levels is becoming more important.

4. Finally, there is concern about climate effects from the build-up of carbon dioxide (CO_2) in the atmosphere from combustion of all carbon fuels including oil, gas, coal, and wood. Currently there is uncertainty about CO_2 inputs from various sources, the absorption of CO_2 by various sinks, and the consequences of the effects of rising CO_2 content in the atmosphere. If the effects prove as serious as some researchers predict, the resulting situation would call for extraordinary kinds of international cooperation to control world fuel combustion or, alternatively, the amount of deforestation. Even though some people believe that immediate action is necessary, most expect that there are at least several decades to evaluate the CO_2 climate modification issue. We urge strong support of research to improve our understanding of the effects of CO_2 on climate and to expand studies of the impacts of climate change.

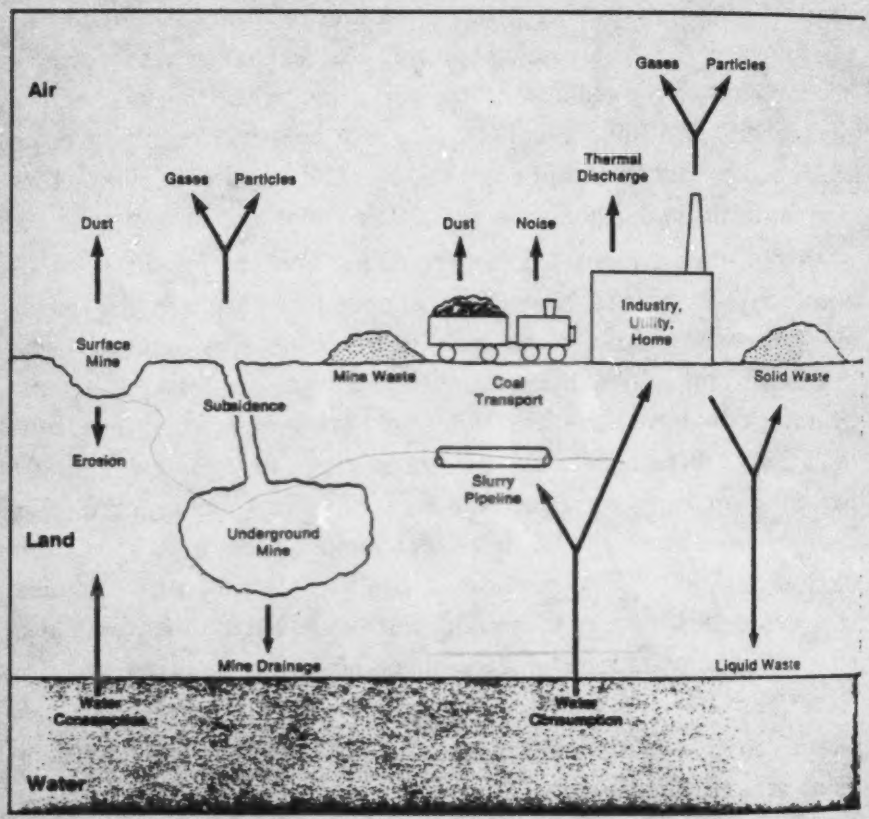
Figure 4-1 illustrates some environmental disturbances from coal-related activities. It shows only the by-products from these activities, not their possible impact on public health or on the ecosystem at large.

Surface Mining

Much of the increase in coal production to the year 2000 is expected to come from surface mines. Therefore satisfactory reclamation of land after mining becomes important in countries with large surface mineable reserves.

In some countries, such as the Federal Republic of Germany, reclamation has been practiced on a large scale for many years. Large sections of land are planned for mining many years in advance, towns are moved, and people relocated. After the land has been mined and

Figure 4-1 Environmental Disturbances from Coal-Related Activities



Adapted from *The Direct Use of Coal*, Prospects and Problems of Produ tion and Combustion; Washington, D.C., Office of Technology Assessment, p. 184.

reclaimed, new towns are developed and people moved back into the area. Such large-scale activities require a clear commitment to the need; a suitable legislative framework; appropriate soil, climate, and depth of seams; long-range planning; and heavy investment for many years before the first coal is mined. For example, near Aachen, development of the Hambach deep-cast mine began in 1957, with a comprehensive drilling program. The first coal will be produced in 1982, and production will be increased until it reaches 50 million tons per year in the mid-1990s—40 years after initial drilling began.

In other countries, in an era of less concern for the environment, coal was surface mined and the landscape was destroyed. Even today in some regions, particularly in the developing countries, restoration is still minimal, especially if the costs are high. But most countries now have experience with land reclamation, and laws controlling it; "surface mining and reclamation" has become a single phrase. Moreover some mined-out areas are now being restored. For example, under current U.S. laws, a reclamation fee of $0.35 per ton of hard coal and $0.10 per ton of lignite from new surface-mined coal—a small fraction of the mining cost—is levied in order to finance reclamation of abandoned surface-mined land.

It is now possible with current technology to restore most surface-mined land to a condition equal to or better than the prior condition at a reasonable cost. Generally, reclamation is easier for flat areas. In arid regions, on steep mountain slopes, or in areas with fragile ecological systems reclamation is more difficult, and some such areas may not be licensed for mining under laws now in effect in several major coal-producing countries. Land areas critical for other purposes may also be excluded from mining. Australia, Canada, the Federal Republic of Germany, the United States, and the United Kingdom all have comprehensive legislation for the control and reclamation of surface-mined lands. The Surface Mining Control and Reclamation Act of 1977 in the United States is perhaps the most comprehensive legislation now in effect.

Illustrative cost estimates for surface mining reclamation are listed in Table 4-1. The actual costs per ton vary from mine to mine and according to the thickness of the seam being mined. The added

cost per ton of coal to reclaim the land is in most cases not over 10 percent of its sales price; in many cases it is negligible.

Table 4-1 Illustrative Surface Mine Reclamation Costs (1977 U.S. $)

Area	*Per Acre*	*Per Ton*
U.S. Western coal (thick seam)	$3,000	$0.16
U.S. Central coal	5,000	0.89
U.S. Eastern coal (thin seam)	8,000	2.91
Western European average	5,000	Variable

Source: International Energy Agency, *Steam Coal Prospects to 2000* (Paris, Organization for Economic Co-operation and Development, 1978), p. 84.

Underground Mining

Underground mining, although less visible than surface mining, has its own set of environmental problems.

Underground mining can cause land subsidence—sinking into the area that has been mined. Where the room-and-pillar method of mining has been used, the problem of subsidence is usually not great. However, the room-and-pillar method leaves as much as half the coal in the ground. Another approach is to allow the surface of the land to subside after the removal of the underground coal and to provide for quickly and fairly carrying out repairs or giving compensation for any damage that may occur. This approach can be used only under certain geological conditions and usually when the long-wall method of mining is used. It is currently employed in the United Kingdom and other European countries. In the United States the cost of past damage caused by subsidence is being partially borne, under new legislation, by a reclamation fee on active underground mines of $0.15 per ton. In any case the cost of managing subsidence damage is a small percentage of the sales price of the coal.

Large quantities of solid waste are produced from surface and underground mining, as well as from coal preparation plants. This must be disposed of in surface piles that can be landscaped, as landfill, by returning to the mine, or by use as a construction material. In areas where the waste material contains contaminants such as high levels of sulfur, prevention of leaching requires careful control of water flows near the storage area, or may even require special ponding arrangements. Similarly, waste water pumped from some mines may contain such contaminants in amounts that must be controlled. How-

ever, in some areas this problem is not great. In fact the United Kingdom frequently puts such water to use in industry.

Occupational Health and Safety

Occupational health and safety are important concerns in coal mining. The major occupational health effect of coal mining has been the lung disease caused by breathing in the dust, pneumoconiosis (black lung disease). Reduction of dust levels by improved ventilation and filtration systems, dust suppression by water-spraying or by laying powdered limestone, and the application of strict work rules and practices have done much to reduce the risk of this disease. For example, the National Coal Board (NCB) of the United Kingdom reports that such measures have reduced by 40-fold in the last 20 years the incidence of pneumoconiosis in miners under the age of 35 years, as well as a similar reduction in other industrial diseases among miners. Improvements in occupational health are also reported by the mining industries of other industrialized countries.

Mine safety has similarly improved, if not quite as rapidly as improvements in health. In the United Kingdom, fatalities in deep mining are about 1 per million shifts worked. This record is 3 times better than those of the United States, the Federal Republic of Germany, France, or Belgium. It is more than a 5-fold improvement since 1952, which in turn was more than a 5-fold improvement on the rate 100 years earlier.

The causes of the catastrophic mine accidents of the past are now much better understood, and safety precautions are taken against the two worst hazards, gas explosions and flooding, both of which are now rare. Minor accidents have been reduced as well as a result of stricter legislation and regulation, the application of the results of research into safety, better training, and active safety programs. The technical improvements and greater mechanization of mining have also contributed to safety by reducing the number of miners per ton of coal produced. By designing out some of the hazards in the mining process, by removing men from hazardous areas, and by creating a high awareness of the need for stringent safety precautions, the mining industry has been steadily improving its health and safety performance.

In the United States, the new safety requirements of the Mining Enforcement and Safety Administration have considerably im-

proved occupational safety conditions and have increased the labor cost of underground mining by approximately $4.00 per ton. With the stricter standards now enforced in most countries, occupational hazards of coal mining are becoming comparable to those of the construction industry or the high-risk manufacturing industries. The health and safety record in surface mines has already surpassed such a level. Still in some mining regions there is room for concern about the numbers of accidents that occur.

Coal Preparation and Cleaning

To date, coal-cleaning procedures have been designed mainly to remove some of the impurities in order to increase the heat content of the coal and to decrease the ash content being shipped and handled at the combustion site. Coal-cleaning procedures are being modified to reduce sulfur and trace elements in order to facilitate meeting environmental standards.

Mechanical cleaning processes based on differences in the specific gravity or surface characteristics can remove as much as half the sulfur content of some coals. Several chemical and mechanical processes are under development that may remove sulfur bonded chemically to the carbon in the coal.

Although coal preparation plants improve coal quality and thereby reduce emissions, they may themselves become significant sources of pollution. Up to 25 percent of the raw material mined, including some coal, must be disposed of as wastes. These wastes, like those from coal mining itself, have few uses and must be stored indefinitely and in a manner that minimizes the leaching of trace materials and soluble salts. Careful compaction and layering can reduce such pollution to levels that meet environmental standards.

Heat drying of the cleaned coal is expensive, uses energy, and may cause dust problems. The cost of meeting U.S. emission standards for particulates during coal drying is about $0.06–0.07 per ton of coal. Heat drying is now being replaced with mechanical dewatering, which costs less and avoids dust.

Recirculation and treatment of the wash water are integral parts of the operation of modern coal-cleaning plants, in order to reduce the amount of water used, eliminate discharge to streams, and allow recovery of coal fines. Compliance costs in the United States for waste water treatment are about $0.07 per ton of coal cleaned

Such techniques are also used to clean up the acid water pumped from some mines.

Altogether the costs of meeting environmental standards in coal preparation are very small in relation to the sales price of the treated coal.

Coal Transport and Storage

Inland transport of coal is by truck or conveyor belt for short distances, and by barge or train for long distances. Transport across oceans is by typical bulk cargo-carrying ships. The principal environmental disturbances are dust, train noise, train or truck congestion, and the risk of accident causing property damage and risk to human life.

Dust can be controlled, by spraying with water and other techniques for approximately $0.05 per ton shipped. Oil is sometimes used and costs about $0.50 per ton of coal, including a credit for the heating value of oil added to the coal.

Coal slurry pipelines offer a promising alternative to barge and train for long-distance transport of coal. Located underground, they eliminate dust, railroad noise, and congestion, but require large quantities of water—one ton of water for each ton of coal transported. In some coal-mining areas water is in relatively short supply. This will either restrict the use of coal slurries, force the importation of water for this purpose, or require the use of some other liquid. Dewatering of the slurry at the receiving point and processing of the waste water can be done with available techniques for $0.15 to $0.25 per ton of coal shipped.

The effects of pollution from accidental spills during the transport are much less for coal than for oil. The risk and potential effects from accident, either in transport or in storage, for coal are not at all like those for liquefied natural gas.

Controlling dust problems and water pollution from leaching at coal storage piles at ports and at using facilities can be done at small incremental costs. Such coal piles must be managed, such as by compacting, to prevent spontaneous combustion from the reaction between the coal and atmospheric oxygen at ambient temperatures. This has been done successfully for many years. The visual impact of coal storage may, however, require that enclosed storage be used more extensively and that greater care be taken to protect the aesthetic and

recreational value of adjoining areas. Moreover, land requirements for coal storage competes with the use of such land for other purposes.

Table 4-2 gives indicative costs for specific environmental protection measures in connection with coal mining, cleaning, and transport under conditions now prevailing in the United States. To get an indication of their scale, these costs can be compared with the delivered cost of steam coal in the United States which averaged about $25–30 per ton in 1977.

Coal Combustion

Coal combustion releases a number of different substances into the atmosphere. Greatly reducing the quantities of such products emitted into the atmosphere requires high costs for emission control. Cleaning up some of the emissions, especially sulfur, creates new waste disposal problems such as limestone sludge from flue gas desulfurization. Because there are substantial areas of disagreement among experts as to the effects of these emissions, it is not surprising that national policies differ widely on emission control goals and strategies.

Particles and gases from man-made sources together with dust particles and gases from natural sources are continually being released into the atmosphere, where secondary particles are formed by reactions among the primary particles and gases. Winds can transport these particles and gases for hundreds of miles, mixing them continuously. To determine the effect of one component of this mixture on the environment, or on the life expectancy of heterogeneous populations, is difficult at best. We do know that infrequent high concentrations of pollutants in the past, such as that which descended on London in 1952, can trigger a discernible increase in the death rate, especially among the elderly and chronically ill. Such incidents have occurred when meteorological conditions concentrated local emissions for at least several days.

Various gaseous and particulate substances from coal combustion at high concentrations are known to increase the rate of respiratory disease, aggravate asthma, cause headaches and chest pains, impair pulmonary functions, and cause general fatigue in susceptible members of exposed populations. Recent epidemiological studies do not provide clear evidence of a relationship between premature mortality and the sulfur oxide levels commonly found in the air of large cities. However, a slight correlation is observed between premature

Table 4-2 Indicative Cost Estimates for Specific Environmental Measures ($/ton of coal, 1977 U.S.)

	COAL MINING AND CLEANING				
	Contour Surface Mining (thin seams)	*Area Surface Mining*	*All Surface Mining*	*Underground Mines*	*Comments*
1. Reclamation of active mines (including prevention of mine subsidence)	2.60–3.00	0.15–0.90		1.00–5.00	Higher for surface mining in steep sloped areas
2. Fee for reclamation of abandoned mines			0.10 (Lignite) 0.35 (Hard Coal)	0.15	U.S. legislation
3. Dust control			0.10–0.20		
4. Mine drainage control	0.35–0.50	0.15–0.40		0.07–0.60	1985 technology
5. Occupational health and safety requirements				6.00	
6. Coal cleaning—prevention of runoff from storage and wastes			0.09	0.09	Per ton cleaned

	COAL TRANSPORTATION			
	By Rail	*Slurry Pipeline*	Harbors	
1. Dust control, prevention of spills, control of runoff	0.05		Unknown	
2. Treatment of slurry water		0.15–0.25		Reduced by evaporating

Source: International Energy Agency, *Steam Coal Prospects to 2000* (Paris: Organization for Economic Co-Operation and Development, 1978), p. 93.

mortality and fine particulates that may come directly from particulate emissions or that may be created by the daughter products of the original sulfur dioxide or nitrogen oxide emissions. It is very difficult to distinguish effects of such products using correlations with such variables as socioeconomic class or prevailing weather conditions. Controlled human clinical studies to date show no significant discernible adverse health effects from "worst case" exposures to sulfates at levels several times the proposed U.S. ambient standards. The long-term effects of daily exposure to existing pollution levels, however, remain unknown. Nonetheless, many governments are adopting sulfur emission standards.

Emissions may also damage crops, fisheries, and materials. A wide variety of field, vegetable, fruit and nut, forage, and forest crops are sensitive to sulfur and nitrogen oxides under controlled exposures. Limited field studies to date indicate potential reductions in crop yield for some species, but increases in yields have been found in soils deficient in sulfates. Lakes in several parts of the world appear to have recently become acidic and, in a number of cases, the fish population has disappeared. Sulfur and nitrogen oxide emissions contribute to acid rain. It is still unclear what mitigation strategy would be most cost effective. As a remedy, some researchers have suggested the addition of lime to affected areas to buffer such acids.

Damage to nonliving materials from emissions is of concern in a number of countries. The soiling problem commonly associated with coal combustion has been all but eliminated, but remaining problems include deterioration of building materials and works of art, fading of dyes, weathering of textiles, and the corrosion of metals under long-term exposure to acidic deposition.

In addition, changes in visibility may occur in some areas. For example, some sulfur dioxide is converted in the atmosphere to sulfates that scatter light and may reduce visibility. This effect is most noticeable in dry regions such as the western United States, where the prevailing visibility may exceed 100 km. The problem of reduced visibility in cities has, however, been greatly diminished by the use of smokeless fuels or the virtual disappearance of small-scale residential and commercial uses of coal. The associated decrease in ground-level dust emissions has increased visibility. The elimination of the "pea-soup" fogs in London since the 1950s is an often-cited result of the requirement that only "smokeless" fuels be burned in the city.

National Air Quality Standards

Some countries control the potential adverse impacts of emissions on the environment by establishing national air quality standards that specify the maximum concentrations of certain chemicals permitted in the air. The principal standards, usually called primary air quality standards, specify the levels of pollutant concentration that cannot be exceeded in order to protect human health. Secondary air quality standards set limits on levels of pollutant concentration that cannot be exceeded in order to protect public welfare (vegetation, property, scenic value, etc.). Portions of present ambient air quality standards of several World Coal Study member countries are shown in Table 4-3.

Some countries do not have such ambient air quality standards. This does not mean that no attempt is made there to control pollution, but rather that different means of specifying and achieving air quality standards are used. Moreover, even in those countries with ambient air quality standards, methods of application may differ. In one case these standards may be stated as goals, to be achieved by whatever means are appropriate; in another they may include express prohibitions on the use of particular grades of coal or require specific actions to control emission sources.

Emission Limitations and Strategies

In order to achieve their stated air quality standards, national governments establish regulations limiting the rates of emissions from sources such as coal-fired electric power plants. In some countries, even more stringent standards are established by local governments. The major emissions that are regulated include sulfur dioxide (SO_2), particulate matter (total suspended particulates or TSP), and nitrogen dioxide (NO_2). Present national and regional standards for these emissions from new sources for several countries participating in the World Coal Study are given in Table 4-4.

Various approaches are used to determine allowable rates of emissions. Virtually all countries require some control of at least the larger particulates at the point of combustion. Some countries, such as France, the Federal Republic of Germany, and Italy, control the SO_2 concentrations by limiting the sulfur content of the coal burned. Others, such as the United Kingdom, rely on mechanical dispersion of emissions by tall stacks and prevailing winds. Intermittent control

Table 4-3 Illustrative National Ambient Air Quality Standards (mg/m³)

Country	*SO_2*	*TSP*	*NO_2*	*NO*	*CO*
Australia	No national ambient standard	No national ambient standard	No national ambient standard	No national ambient standard	No national ambient standard
Denmark	0.75[a]	0.25[a]	No national ambient standard	No national ambient standard	No national ambient standard
Federal Republic of Germany	0.14[b] 0.40[c]	0.2[b] 0.4[c]	0.1[b] 0.3[c]	0.2[b] 0.6[c]	10.0[b] 30.0[c]
Italy	0.25[m] 0.10[f]	No national ambient standard	No national ambient standard	No national ambient standard	No national ambient standard
Japan	0.14[d]	No national ambient standard	0.4[d] 0.8–0.12[e]	No national ambient standard	No national ambient standard
Netherlands	0.075[b] 0.25[c]	0.03[b] 0.12[c]	No national ambient standard	No national ambient standard	No national ambient standard
Poland	0.075[f] 0.35[g]	0.075[f, h] 0.2[g, h]	0.05[f] 0.2[g]		0.5[f]
United Kingdom	No national ambient standard	No national ambient standard	No national ambient standard	No national ambient standard	No national ambient standard
United States	0.36[d, i] 1.3[e, j]	0.26[d, i] 0.15[e, i]	0.1[k]	No national ambient standard	10.0[l]

[a] monthly average;
[b] long term;
[c] short term;
[d] primary standards (protective of human health);
[e] secondary standards (protective of public welfare, i.e., materials, flora and fauna);
[f] daily average for sensitive areas;
[g] daily average for non-industrial areas;
[h] particles less than 20μm;
[i] daily average;
[j] 3-hour average;
[k] annual average;
[l] 8-hour average;
[m] 30-min average.

Source: WOCOL Country Team Reports.

Table 4-4 New Source Performance Standards for Coal-Fired Power Plants (mg/m³)

Country	*SO_2*	*TSP*	*NO_x*	*CO*
Australia	No standard	250	2,500	500
Denmark	No standard	150[a]	No standard	No standard
Federal Republic of Germany	2,845[b]	100[c] 150[d]	State of the art considered	250
Italy	2,000	No standard	No standard	No standard
Japan	500[e] 2,500[f]	200[e] 400[f]	767	No standard
Netherlands	No standard	No standard	No standard	No standard
Poland	No standard	No standard	No standard	No standard
United Kingdom	No standard	115	No standard	No standard
United States	1,900[g]	45[h]	950[i]	No standard

[a] mg/Nm³
[b] converted from 2.75 g/kWh
[c] lignite
[d] hard coal
[e] urban
[f] rural
[g] converted from 1.2 lbs/10^6 BTU
[h] converted from 0.03 lbs/10^6 BTU
[i] converted from 0.6 lbs/10^6 BTU

Source: WOCOL Country Team Reports.

strategies are allowed in some countries such as Denmark—high-sulfur fuels may be used under favorable wind and weather conditions, and low-sulfur fuels must be used under adverse conditions. Some countries, such as the United States and Japan, rely on combined chemical and mechanical systems as well as on low-sulfur fuels to reduce emissions.

CO_2 and Climate Change

Because technical solutions for controlling CO_2 emissions are prohibitively expensive, and because large increases in the amount of atmospheric CO_2 may alter global climate, CO_2 emission poses one of the most perplexing problems resulting from the increased use of fossil fuels including coal. CO_2 is a trace gas in the atmosphere. In spite of its relatively small concentration (330 ppm) it has an influence on atmospheric temperature. It is largely transparent to sunlight, but it absorbs the infrared radiation emitted from the earth's surface and reradiates part of it, thereby reducing the rate of surface cooling. Consequently, it is thought that an increase in atmospheric CO_2 will contribute to a rise in the earth's temperature that has be-

come commonly known as the greenhouse effect. Such an increase in the earth's average temperature would probably modify climate patterns, benefiting some regions but possibly bringing disaster to others.

For many reasons the issue of climate modification caused by increasing CO_2 in the atmosphere is more complex than the other environmental problems caused by fossil fuel combustion. There is a disagreement among scientists about the magnitude and urgency of the problem and about the detailed interactions involved.

CO_2 is absorbed, stored, and exchanged by the world's oceans, forests, soils, and sedimentary rocks in complex ways. This process is shown in a schematic form in Figure 4-2. Major sources of CO_2 are respiration from animals and decay of vegetation as well as evaporation from the oceans. Absorption of CO_2 by photosynthesis of plants and dissolving in the ocean are the sources of removal of CO_2 from the atmosphere. The input from fossil fuel combustion is small compared with the other fluxes, whose magnitude is not well established. In addition, the global atmosphere has been cooling since 1940 after an 80-year warming cycle. One of the difficult problems is to distinguish fossil fuel combustion effects from massive natural cycles of climate change.

People have been adding CO_2 to the atmosphere at an increasing rate since earliest times by destruction of the natural vegetative cover, changes in land use, and since the industrial revolution by the burning of fossil fuels. CO_2 in the atmosphere has increased by about 15 percent during the last century and is now increasing at about 0.4 percent per year. The effects of this are not yet predictable; natural feedback mechanisms such as increased cloudiness may act to moderate the greenhouse effect but such cloud cover, despite its high reflectivity to solar radiation, may reduce surface cooling even more.

On an energy content basis, coal combustion releases 25 percent more CO_2 than oil and 75 percent more CO_2 than natural gas. Large increases in coal combustion will have an effect on the level of atmospheric CO_2, but whether this will be significant in comparison with other mechanisms at work in the earth's carbon cycle is uncertain. Moreover, even if scientists agreed about the exact effects of CO_2 on climate, we do not now have international political systems capable of acting to prevent any further increases by restricting global fossil fuel combustion or by reducing the rate of deforestation.

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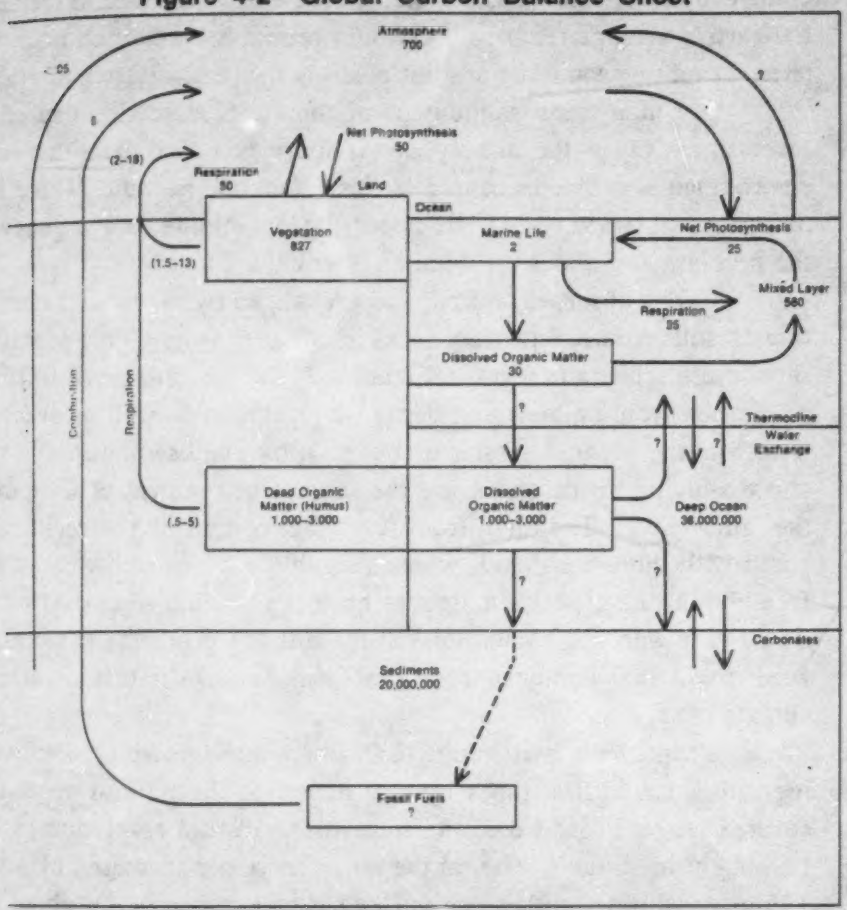
Figure 4-2 Global Carbon Balance Sheet



Source: From "The Carbon Dioxide Question," by George W. Woodwell. Copyright © 1977 by Scientific American, Inc. All rights reserved.

The Global Balance Sheet shows major carbon repositories and annual exchange rates among depots that are in contact. Quantities are expressed in units of 10^{15} grams, or billions of metric tons. Annual releases to the atmosphere governed by human activities are shown in color. Land plants fix a net of about 50×10^{15} grams of carbon per year. This carbon is either consumed and promptly respired by various terrestrial organisms or stored in the plant mass. The balance between fixation (net photosynthesis) and storage plus the total respiration of all terrestrial organisms determines whether there is a net flux of carbon dioxide to or from the biota. Many biologists now believe that there has been a long-term net flow of carbon dioxide from the biota into the atmosphere and that the flow is continuing. The carbon fixed by marine organisms is either respired or stored. It has been commonly assumed that most of it is respired immediately and recycled. It now seems possible that sinking fecal pellets may carry more carbon into the oceanic depths than had been thought. This transfer would supplement the normally slow diffusion of carbon dioxide into the surface layers of the ocean, where it comes into equilibrium with the carbonate-bicarbonate system. Although the deep ocean provides a virtually unlimited sink for carbon dioxide, gas must enter the mixed layer and then penetrate thermocline, a thermally stratified layer that impedes mixing with deeper layers.

The issue of CO_2 climate modification requires sustained and expanded research efforts on both a national and an international scale. Progress in atmospheric theory is being made possible by improved models of global circulation supplied with much more extensive data. It may happen that some effects of CO_2 will become detectable on a regional and global scale before the end of the century, and will require a reassessment of world fossil fuel use at that time.

Solid Waste

The combustion of coal leaves behind a solid, unburnable residue called bottom ash. In addition, solid particles called fly ash are taken out of the flue gases by precipitators, filters, or scrubbers. Finally, the flue gas can be reacted with various agents to remove compounds from some of the gas, for example, lime or limestone slurries to remove SO_2. This produces a mixture of solids and water called sludge.

Some such solids are put to practical use. Fly ash and bottom ash are used commercially in cement making, in road building, as building materials, or as land fill. In the United States about one-third of the ash is so used, and in some European countries it is as much as one-half. Other avenues of use are being explored. The remaining materials must be disposed of in an acceptable way. Traditionally, both types of ash were disposed of by stacking in nearby land, frequently in lined pits to prevent water from leaching out contaminants. The cost of such disposal per ton of coal burned depends on land availability and lies in the range of $0.05 to $0.40 per ton of coal burned.

Sludges, on the other hand, are much more difficult to dispose of, and the cost for disposal is as much as $2 per ton of coal burned. Technologies are therefore being developed that result in a dry form of residual, such as gypsum, or in a useful product such as chemical sulfur.

Ash and sludge carry trace elements of materials contained in the original coal. Although some of these substances are toxic at high concentrations, it is unclear whether they are harmful when diluted as they are found in ash and sludge. A requirement that ash and sludge be disposed of as hazardous material could increase costs substantially. Depending on what needs to be done for disposal, the

cost could reach $0.50 to $10 per ton of coal burned. In some countries, there is still much uncertainty about disposing of ash acceptably and what such processes would cost. In large-scale coal-consuming countries, nonconventional disposal centers may be needed in the future. Cost estimates for various waste disposal techniques are given in Table 4-5.

Thermal Emissions

Cooling is required in power plants and other large boilers whether fueled by coal, oil, gas, or uranium. Water is most often used for cooling. If the amount of heat is large and the water body receiving it is small, the thermal change in the natural environment can upset the ecosystem. To avoid such effects the heat can be dissipated by evaporation in a cooling tower at a cost of about the equivalent of $1 per ton of coal.

A great amount of the heat is dissipated by evaporation of the water, whether in a cooling tower or in a once-through cooling system. In areas where water is in short supply a completely closed system, much like an automobile radiator, can be used to dissipate the heat. Depending on the humidity and temperature, such systems cost the equivalent of $10 to $20 per ton of coal used.

Land and Water Use

The siting of coal production, transport, storage, and use facilities all involve the use of land. Such use competes with other functions for the land such as farming, residences, and recreation. In areas of dense population this competition is particularly acute. Methods of allocating the rights for use of such land differ among nations, but increasingly conflicting use is creating difficult problems to be solved by custom, marketplace, regulation, administrative fiat, or legal processes. In some countries and localities these increasing difficulties are leading to development of comprehensive planning for allocation of land and water among competing needs.

Similar conflicts over the use of water resources are also increasing. This involves the rights to use water for coal processes in mining, in slurry pipelines, in converting coal to gases or liquids, or for cooling in electric generating stations. Other uses of water may

Table 4-5 Comparative Cost Estimates for Specific Environmental Measures for Electric Utility Coal Utilization—New Sources (U.S. $/ton-1978)

	Australia	Denmark	Federal Republic of Germany	Japan	United States
Control of thermal discharges—cooling towers					
Wet	0.42	—	0.8–0.9	—	0.8–0.9
Dry	—	—	15.0–18.0	—	7.0–11.0
Particulate control					
ESP	0.80	1.00	2.0–3.0	1.6	1.5–2.0
Baghouse	—	—	—	5.4	1.6–1.8
SO_x Control					
Limestone FGD	—	—	20.0–25.0	14.2	7.0–18.0
Regenerative	—	—	—	—	17.0
Dry FGD	—	—	—	—	9.0–30.0
NO_x Control					
Combustion control (where possible)	0.20	—	—	0.8	0.2–0.5
Postcombustion control—NO_x selective	—	—	—	4.7	6.0–9.0
Postcombustion control—SO_x/NO_x scrubber	—	—	—	—	7.5–18.0
Combustion by-products disposal					
Ash—conventional	0.25	0.35	—	3.9	0.3–0.7
Ash—as hazardous material	—	0.45	—	—	5.0–10.0
Ash plus FGD sludge—conventional	—	—	—	—	2.5
Wastewater treatment					
Conventional	—	—	—	0.9	0.3–2.0
Zero discharge	—	—	—	—	2.0–3.0
Noise control—external plant only					
FD Fans	—	—	—	0.2	0.2–0.5

Source: WOCOL Country Team Reports. -- not available.

be agricultural, domestic, or industrial. Also the warmed water body may be viewed as an important fishing resource. These forms of competition for the water resource are leading to additional problems just as with the land resource.

Costs of Pollution Control for Utilities

The comparative costs for specific environmental measures for electric utility coal utilization in a number of countries are shown in Table 4-5. It should be stressed that environmental control measures usually require energy. For example, addition of sulfur removal facilities and a cooling tower may result in as much as a 10 percent loss of the output of a generating station. The energy costs are included in the estimated cost shown in Table 4-5.

Coal Use in Industries Other Than Utilities

Coal use other than for electricity generation is mainly in the metallurgical industry, where coal is used essentially as a chemical feedstock. Such coals are typically high quality, with a low content of sulfur and other impurities, and produce relatively low emissions of sulfur oxides and particulates. Such coals usually sell at a premium price. Their increased use, within the scale projected in WOCOL, may produce some environmental problems in some areas. Emissions from coke ovens represent special problems that can be handled adequately, although they may be expensive to deal with.

Steam coal, when it is used to generate electricity or raise steam in the industrial sector, may not have to meet the same environmental requirements as the same coal used in the utility sector. The same may be true for steam coal used in the commercial or residential sector to produce heat. On the one hand, because the amount of coal used at any location is so much smaller than the amount used by a utility, the environmental rules may be much less stringent. On the other hand, because such use is typically in areas of much greater concentrations of population and other environmental effluents, the environmental rules may be much stricter than for rural-sited generating stations. In any case, for identical emission standards, it is likely that the cost per unit of coal used will be high in small installations. Such a generalization, however, must be applied

with caution because different technologies can be applied to achieve the control of emissions, and a technology applicable to only small-scale installations may be low in cost per unit of coal used. For example, if fluidized bed combustion is available and acceptable for small-scale installations, the cost of sulfur emission control per unit of coal could be considerably less than from a lime or limestone scrubber now used at generating stations.

New Coal Conversion Technologies

New coal conversion plants to make gases and liquids from coal will have to remove and dispose of ash, particulate matter, and sulfur and nitrogen compounds in the same way as do power plants. Some of these processes may have an advantage. For example, the ease of adding limestone to a fluidized bed to control sulfur may make it the preferred technology, but the amount of sulfur removed may not be sufficient to meet certain national standards.

About 20 percent or possibly more of the coal used by synthetic fuels conversion plants will be burned to supply heat and power for the synthetic process itself. Additional emissions will result from purification of the synthetic fuels. Depending on the technology used, these will take the form of potential air and water pollutants or solid waste, and they will all have to be controlled.

The extent of the environmental impact from coal-based synthetic fuels production is not clear. Synthetic fuel processes are complex; up to 80 classes of compounds of potentially hazardous substances may accompany the coal conversion process. In addition, there are currently very few data available on the characteristics of emissions from the various possible conversion processes because no commercial-scale plants have been built except in the Republic of South Africa. The major environmental problem will be controlling the production and release of potential carcinogens (primarily, complex organic compounds) during the coal conversion as well as controlling possible toxic materials in the waste. Because the basic costs of coal conversion will almost certainly be high, the additional costs of controlling emissions will probably be an acceptable fraction of the total cost given the market values and clean nature of the liquid and gas fuels produced.

The large quantities of water needed for all coal conversion

processes may prove to be a major resource constraint on their development in areas in which water supplies are severely constrained.

Whether the various processes (high-calorific value gas, low-calorific value gas, solvent-refined coal, or liquefied coal) will represent a reduction of environmental pollution compared with the direct combustion of coal will depend on the degree of emission control used and the effectiveness of such control. Such evaluations are difficult at this stage of development of the different technologies, but it is likely that measures to control whatever environmental problems may arise will be found. Whether they will be cost effective is the question that must be determined by research.

The Need for Research

A number of improved technologies to reduce environmental effects from coal mining, transport, and use are currently under development. For example, improvements in underground mining to reduce the occupational hazards of miners, and better methods to remove sulfur oxide from flue gas, are well along in development. Such research is important to reduce the cost of environmental control and to improve the ability to remove contaminants from the environment. This includes the improvement in the workplace to reduce worker exposure to accident or health risks.

Recently, concern has been expressed as to the effect of small (submicron) particles on human health. Research is needed to determine whether the risks from such emissions are sufficiently high that further control is needed.

Also, a great deal of research has been under way in the last two decades to evaluate the effects of environmental contaminants. The research has involved primarily human health effects but also effects on ecosystems. It is this work that has made society more aware of the environmental risks it is taking, and has led to the environmental control strategies taken by various nations. It is important to continue such research so that additional controls can be aimed at those areas of greatest environmental risk, and so that control can be relaxed in areas found to be less necessary.

COAL NOT THE ONLY CAUSE OF PROBLEM

Mr. WILSON. The first thing I wanted to emphasize was that all fossil fuels when burned produce CO_2. Coal produces 25 percent more than oil and 75 percent more than gas. But the villain is not just coal, it is all fossil fuel combustion.

Representative REUSS. That's why I used fossil fuels. Our beloved wood is very bad.

Mr. WILSON. But so often, coal is identified as the villain. It produces a little more than oil, I'd say, 25 percent more, and a lot more than gas. But it's not the only villain.

In the WOCOL study on the CO_2 question, we relied on the conclusion of a World Climate Conference at WMO in Geneva in 1979, which included a major focus on any CO_2 effects. Their conclusion was that on the basis of past growth rates of fossil fuel use; that is, 4 percent per year—effects on climate of CO_2 from fossil fuel combustion might be detectable by the end of the century and might be significant by the middle of the next century.

You will recall the diagram—figure 4—in which we projected the growth rate of all energy use, mostly fossil fuels, would drop well below 2 percent over the next 20 years. This doesn't mean that the problem goes away but it does mean that we have a little more than twice as long at a 1½- to 2-percent growth rate for fossil fuel combustion, as was used in the world climate projections using a 4-percent basis.

In this chapter there's a diagram from the Scientific American showing the enormously complex carbon cycle with ocean transfer and decaying vegetation and so on, very large numbers in relation to the amount coming from fossil fuel combustion.

But, it is certainly true that accurate measurements show that the CO_2 in the atmosphere is increasing at about four-tenths of 1 percent per year and that's a rate of increase that will certainly double the levels of 330 parts per million in 100 years or so.

We recommended in this report a lot more research and measurement of atmospheric temperatures. Most of the projections now, and the most widely accepted, are based on theoretical global circulation models which have become much more interesting in the last 10 years. But, they are still theoretical models. Some things are very hard to take into account, so in the WOCOL report we have recommended that a lot more measurement be done and that more work be done to assess the effects of a global warming.

We did not foresee the emergence of any global regulatory system that would, even if the scientists agreed, have the ability to reduce the use of fossil fuel around the world. So we did urge that there be a hard look taken at what would be the consequences of a global warming.

Fortunately, one of the leaders in this field who was active in our study 10 years ago. Mr. William Kellogg of the National Center for Atmospheric Research, has done that and published a year ago a study of climate change and society in which he says:

> Suppose it doubles. What can we estimate as to what the effects would be and what rates of changing the precipitation, of increasing the cloudiness, of moving the average temperature in different places.

And, given limits of the ability to project these things, they came out with the conclusion that there would be a mix of effects, some beneficial:

More CO_2 in the atmosphere, more for plants to take up because that's what they use for their respiration; shifts of areas, more precipitation some places than others.

Their conclusions were, and recommendations, that if we really devoted substantial efforts to improving the climate resilience of our agriculture, more drought resistant, more resistant to changes in early and late frost and so on, we would derive many benefits along the way and do the major thing to cushion the effects of a global warming if it comes. And it seems to me that's a hopeful direction in addition to a lot more measurements.

My conclusion on this is that the state of knowledge is very uncertain. I did see that article in the Washington Post a week ago. This is the view of some scientists, but the range of estimates among scientists as to the effects of a doubling of CO_2 range from 0.25 to 2.5 degrees.

So, there's still a large range in there and I think much more work needs to be done. And I think the article last week in the paper, of the AAAS, was very much a kind of doomsday kind of thing with which most scientists would not agree.

I might say the author of this book, Mr. Kellogg, said: "In the book we say that the state of knowledge of the effects of CO_2 on climate does not justify action to limit the use of fossil fuel." And he says: "I could not agree more with this point."

Representative REUSS. Thank you for that very clear tour of the atmospheric horizon, without taking anything at all away from your excellent coal studies recommendation that both research on the effects and measurement of CO_2 be accelerated.

That was a recommendation addressed to the scientific world; that is, to produce some results like the Kellogg study and many other things.

But the purpose of this hearing is a little different. We're Congressmen and Senators. We are considering whether the recommendations of your coal study and other studies should be made, in effect, national policy. There is a rather larger responsibility resting upon us.

ESTABLISHING EMISSIONS MONITOR

And I would ask you this question: Isn't it possible to put in place, internationally if possible or by this country if we must go it alone, a reliable measurement and monitoring device? After all, the Congress has demanded of the Federal Reserve system that they tell us how much M–1(B) they are emitting into the atmosphere. [Laughter.]

Somebody ought to tell us how much CO_2 is being emitted, not the Federal Reserve. And we don't now, unless I'm mistaken, have anybody charged with doing that, do we? I don't know who it would be.

Mr. WILSON. One can compute the uncertainties as to some of the other exchanges in the carbon cycle; that is, from the tropical rain forests into the atmosphere and so on. The numbers are really over wide ranges of uncertainty.

You can estimate fairly closely CO_2 production from fossil fuel combustion if you know what the fossil fuel combustion is in the world and we know it fairly well. We know pretty well who is burning coal and oil and other things, how much CO_2 each country is putting into the atmosphere. Half of it, approximately, stays there. The rest of it goes back into the oceans, probably.

But the other point you make, it seems to me, is a critical one and I think little has been done to set up measurement stations all over the world that really measure the changes in global temperature, regionally and locally. There is no complete worldwide network. It is something they attempted to start at this WMO conference 2 years ago.

But, I think we ought to have a worldwide measuring network that really measures change rather than relying so much as we now do on these theoretical circulation models.

Representative REUSS. Will you tell us the nature of that 1979 Geneva Conference?

Mr. WILSON. The World Meteorological Organization of the United Nations convened a 3-week conference on world climate after a year of preparation.

Representative REUSS. Excuse my ignorance. Who are they?

Mr. WILSON. The World Meteorological Organization is one of the specialized agencies of the United Nations. It was set up when the U.N. was created. It has a number of activities. It brings together the world's meteorologists, climatologists, and others.

Although much of its previous focus had been on weather, this was the first major conference on climate which has a different time base, as you know. That's what we in WOCOL considered the most authoritative statement, yet it is my understanding that even there they didn't agree on the creation of a worldwide network of temperature measurement stations which, after all, would begin to build up some data.

Representative REUSS. What was the basis of the disagreement?

Mr. WILSON. I'm afraid I was involved in the coal study and didn't go to the WMO conference, so I just don't know. Perhaps there were resolutions adopted for it, but my impression has been that such a network has not been established.

It seems to me that that's the beginning point of measuring it. We can measure the CO_2, really, pretty well. There are stations in Hawaii and other parts of the world which measure CO_2 consistently at the same place, under the same conditions, every year as we do with ozone. But my understanding is that we have no similar network for temperature measurement.

Representative REUSS. Well, it suggests that we should explore whether there is now, in fact, an official reporting service on at least the CO_2 content of the atmosphere. That seems to me essential, because if you found that the 0.4 percent per year was accelerating, that would certainly be an early warning signal.

That again would not indict coal, necessarily, as the villain. It might be the forests, it might be the ocean, it might be agriculture, or it might be oil, or something unknown. But at least we would know that we are steering toward the abyss and we ought to do something about it.

Mr. WILSON. I believe that NOAA, the National Oceanic and Atmospheric Administration, at their station in Hawaii, regularly measures CO_2. Although NOAA as an agency wasn't around 20 years ago, these measurements have been going on.

Whether that is the officially accepted number, I don't know. But I think there's very little dispute among scientists as to the measurement

of parts per million of CO_2 in the atmosphere and I think it comes from the Point Barrow Station and also from the one in Hawaii.

Representative REUSS. Perhaps it simply means regularizing that which may informally exist. We should try to reach a judgment as to what's being done in Hawaii and whether that's enough, and whether somebody has told NOAA: "Look, you're the monitor, you're the watchdog."

Thank you very much, Mr. Wilson. I know you have another engagement. I invite you to sit with us as long as you can.

We'll now hear from the other witnesses, and I'm going to ask them to summarize or give, as they prefer, their statements. And we'll wait for questions until all of them are finished.

Secretary Mares, would you start out, sir?

STATEMENT OF HON. JAN W. MARES, ASSISTANT SECRETARY FOR FOSSIL ENERGY, U.S. DEPARTMENT OF ENERGY

Mr. MARES. Thank you, Mr. Chairman.

I am pleased to represent the Department of Energy in their review of cooperation between the private sector and the Government in realizing coal's potential. Your interest in holding this review is evidence that you believe as we do that coal is a strategic resource, one that can and must play a major role in revitalizing our country and restoring our economic health.

I have submitted a more detailed prepared statement for your use in reviewing this important subject. I would ask your permission, Mr. Chairman, to place that statement in the record and briefly highlight what I believe are some of the central points.

Representative REUSS. Without objection, so ordered.

Mr. MARES. As a starting point for describing the respective roles of Government and industry in the future of coal, it is important to recognize the current competitive advantages offered by this abundant resource. As I have noted in my prepared statement, coal is now roughly $23 per barrel cheaper in terms of energy equivalence compared to oil. Nine years ago the difference was only $2 in favor of coal. That makes coal the most economical fuel today for new, large boilers.

In itself, this is a major stimulus for increasing the commercial use of coal. From an international perspective, coal's advantage lies primarily in the reliability it offers to other countries wishing to diversify their sources of energy.

In my prepared statement I provided figures which illustrate the growth of coal production and use. This growth comes predominantly because of the economic advantages and the relatively high reliability of coal from this country, not because of arbitrary Government targets. Government can and should become a cooperative partner with industry in stimulating the future growth of coal.

THE ROLE OF INDUSTRY

But we must recognize where the line is drawn between appropriate Government involvement and where industry can and should assume the initiative. As I pointed out in my prepared statement, industry is assuming a lead in several coal-related areas. Therefore, the areas where this administration believes Government can play a complemen-

tary and cooperative role are as follows: In accelerating Federal leasing of coal-bearing lands; in returning more flexibility to companies planning mining operations so the pace of their development conforms better to market conditions and not Government pressures; in providing new tax incentives to stimulate plant and equipment expenditures from new coal facilities and increased industrial R. & D.; in taking a more realistic approach to recognizing the scientific uncertainties in such key environmental areas as the impact of CO_2 on world weather patterns; and the relative contributions of various sources to acid rain. I might note here that we have covered that subject in greater detail in the prepared statement.

The Federal Government has been working in the area of CO_2. We have been spending in that area at the rate of $10 million a year in research in order to better understand the global carbon cycle. We are examining the effects of CO_2 on climate, the effects of climatic change, and CO_2 on the physical and biological environment.

Another role for the Government is in recognizing the enormous cost to the consumer of environmental control equipment and adopting a more rational approach to determining the degree of benefits from such equipment before taking precipitous action. We are also removing Government-imposed constraints to coal exports and providing a clear signal to coal importing countries that the United States will remain a reliable source of supply. And last, but certainly not least, maintaining a core program of high-risk, high-payoff research that feeds into the activities of industry but does not compete with them.

HIGH-RISKS TECHNOLOGY PROGRAM

This latter area, the high-risk technology program, is my specific responsibility within the energy department. Therefore I would like to spend a few minutes describing specifically the role we have adopted with industry in restructuring this activity. As you will note in my prepared statement, there are examples of new energy technology where Government has played an important early role in improving technical viability.

Coal oil mixtures is a specific example I've highlighted, based in large part on the work of Federal research laboratories. The concept of mixing brown coal into oil as a way of lessening our dependence on oil is being actively pursued by several private sector utilities and industries.

Therefore, we no longer see a direct Government role in funding additional development in this area. We have targeted our current research on longer range horizons, on higher risk fuels, about which little is known today, yet which have the potential for replacing all of the oil burned by some conventional oil-fired powerplants.

For instance, later this week we're going to be announcing the selection of industrial partners to participate in our program to develop coal-water mixtures, one of these higher risk fuels with a significant potential future. This will be a mixture that would be 70 percent, by weight, coal and 30 percent, by weight, water.

The presence of these firms will assure that Federal work on the front end of the development path of coal-water mixtures will indeed provide the data needed by industry. A similar policy is present in our coal-cleaning program.

Although industry is becoming more involved in cleaning steam coals prior to combustion, the technical options today are limited. For the most part, the available alternatives provide only moderate cleaning of coal. We believe that new techniques, such as the use of microwaves or fused-salt chemical reactions, offer quantum leaps in today's technologies. It may be possible to clean even high sulfur, dirty coal to a quality rivaling that of fuel oil. Industry is interested, but cannot justify the necessary expenditures based on the high-risk, long-term character of the research. Here then is a proper role for Government activity.

In my prepared statement I provide an example of a similar restructuring within our flue gas cleanup and combustion programs. In each, I have made it a high priority to insure that we have open and active communication with the private industry groups, the National Coal Association, the American Mining Congress, the Electric Power Research Institute, and others to insure that our priorities are compatible with the future needs of industry.

In the synthetic fuels area we also believe market conditions have improved the prospects for a commercial industry and have minimized the need for direct Government involvement. However, the magnitude of costs associated with commercial synfuel facilities and the uncertainty of their future competitiveness with conventional energy resources has required a program of limited Government incentives.

In carrying out the congressional mandate for these incentives, the Department of Energy moved first by selecting two oil shale projects and a coal gasification venture to receive loan and price guarantees. These pioneering projects will give private companies their first real live examples of commercial facilities so they can make decisions on the future risks and benefits of additional plans. Yet by emphasizing loan and price guarantees, as opposed to direct cost sharing, we are placing substantial financial responsibility on the private partners. We believe that projects can be conducted in adherence to sound business practices and with a minimum impact on the Federal budget.

The U.S. Synthetic Fuels Corporation now has the lead Government role in supporting this new industry. And they, too, will be giving highest priority to these types of incentives.

In the Department of Energy, we have moved our R. & D. program away from near term, commercial synfuels activities and toward efforts to better understand the mechanisms involved in coal gasification and coal liquefaction. In this way we hope to uncover new, advanced concepts that could return significant future dividends in terms of efficiency and economics.

PROSPECTS FOR COAL TRADE

I have provided in my prepared statement a section on prospects for improved coal trade by the United States. We have seen significant increases in coal exports recently. Coal export levels in 1981, for example, will most likely exceed the projections many studies have made previously for exports in 1985. We anticipate these increases in coal exports will continue, with the major increases coming in the shipment of steam coal, rather than metallurgical coal, as has been the case in the past. This has been the case in what we've already heard in testimony this morning.

The private sector has read the same international signals. Improvement projects are underway at more than 35 ports. U.S. ports should have sufficient capacity within the next few years to handle the anticipated volume of coal exports through the year 2000.

The administration has proposed legislation to recover through users' fees the cost of port and channel improvements and is continuing to examine ways to reduce the permitting time required for these improvements.

We have also sent a clear signal to our international allies that the administration will not interrupt coal trade under contractual agreement unless a severe national emergency requires it.

In the latter parts of my prepared statement, Mr. Chairman, I have summarized what we perceive as the obstacles confronting coal, particularly the capital-intensive nature of coal handling and utilization equipment and the impact of inflation and high interest rates on the ability of firms to finance new coal-fired capacity.

I have also included projections of energy consumption and production, including those for coal, drawn from our national energy policy plan, which was submitted to Congress last summer.

The conclusions from these statements and figures is that while conditions look increasingly favorable for coal, the magnitude and pace of an increase in coal production and use is inherently difficult to gage. Government has historically been a poor predictor of changes in the pattern of energy demand.

This administration has specifically adopted a posture that it will be the marketplace that will judge the true potential of coal or any other energy resource. Our role in relation to the private sector, therefore, is to take those actions which are appropriate Federal functions, actions that can control inflation, actions which can return to industry the responsibility to make commercial decisions, free of unnecessary Government demands and fluctuations in Federal regulations, and an effort to maintain a core research program to insure that advanced energy concepts continue to flow into the industrial pipeline.

I'd be pleased to answer any questions you have, either now or later on, Mr. Chairman.

[The prepared statement of Mr. Mares follows:]

Prepared Statement of Hon. Jan W. Mares

Mr. Chairman and Members of the Committee:

I am pleased to participate in your review of the cooperation between the private sector and government in realizing coal's potential and the role coal can play in revitalizing our country. The Administration has recognized that the abundance of coal in the U.S. makes it one of the nation's strategic resources in both our energy and economic future. It has also recognized that significant domestic and global benefits will accrue as other countries turn toward a coal-rich America as a competitive, long-term, and reliable source of energy.

The 1200-percent rise in world oil prices in less than a decade has imposed a substantial burden on the economies of oil-dependent nations including the U.S. But it has also created an unparalleled opportunity for America's coal industry, both at home and overseas. The difference in the price of coal and oil delivered to utilities in the U.S. in 1973 averaged about $2 per barrel of oil (equiv.) in favor of coal. Today, coal's domestic price advantage over oil has widened to nearly $23 per barrel (given coal priced at $36 per ton and oil at $32 per barrel). Coal is currently the most economical fuel for the majority of new large boiler applications in the U.S. Overseas, the relatively high reliability of American coal supplies is becoming an increasingly important factor in long-term energy planning. Several countries today find it more in their national interests to build new coal-fired power plants and import U.S. coal, rather than continue operating existing oil-fired units.

These strong market incentives -- namely favorable economics and reliability of supply -- provide a starting point for a discussion of the respective roles of Government and the private sector in the future of U.S. coal. The Administration has reformulated energy policy on the basis that government can never perform as effectively as the marketplace in stimulating the production and use of any energy resource. Coal provides an excellent example of these market forces at work.

In 1980, coal consumption in the U.S. was nearly 75 percent greater than it was twenty years before -- and up approximately 25 percent from 1975. More than 80 percent of this consumption was by electric utilities. In 1980, for the first time in more than a decade, over half of this country's electricity was generated by coal-fired boilers. More than 1,330 coal-fired units are now operating, and another 230 are planned to be in operation by 1990. Together, the coal-fired generating plants now operating, under construction, or planned, will need at least 880 million tons of coal annually by 1990. That's more coal than has ever been produced annually in the U.S. for all uses.

Despite the increasing demand, many of the nation's coal fields are still functioning significantly below capacity. The U.S. coal industry experienced a banner year in 1980 when production reached a record level of 830 million tons. In 1981, production was down slightly to about 800 million tons as a result of the 72-day spring coal strike. But it is important to note that as utilities began replenishing their stocks after the strike, production occasionally reached record levels of 19 million tons per week, equivalent to a yearly production of almost 1 billion tons of

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coal. While we recognize that maintaining such a production level for long periods of time would be difficult, the figures nonetheless reflect that we have the national capacity to mine significantly more coal than is currently being consumed.

The private sector is thus fully capable of meeting the anticipated demand for coal in this country, certainly in the foreseeable future. But it can do so only if it is not hampered by counterproductive Federal leasing policies and nonessential regulations. Government, therefore, can play an appropriate role by reducing impediments to the production and use of coal.

Leasing, Regulatory and Tax Reform

In the future, more coal is likely to be produced on Federal lands. The Federal government owns or oversees four-fifths of all the known reserves in the western U.S. -- where low-cost, strippable beds of coal are heavily concentrated. The Department of the Interior has ended a 10-year moratorium on leasing of Federal coal lands, and the Administration is committed to accelerating the Federal coal leasing program and removing inappropriate regulatory barriers to coal production.

Inherent in the revision of leasing policies is the need to return to industry greater flexibility in determining the manner and timing of mining operations. The Department of Energy last month proposed to relax the current June 1, 1986, deadline by which pre-1976 leases must be brought into commercial production or face termination. Instead, under the proposed changes, a company with a pre-1976 lease would be required to produce commercial quantities of coal within ten years after its lease is first readjusted by the Interior Department after 1976.

This action will not discourage production from Federal leases; rather it will help permit Federal coal reserves to be developed as a result of market conditions rather than in response to government pressures and arbitrary deadlines. (The Department of the Interior and Related Agencies Appropriations Act for Fiscal 1982 transferred DOE's leasing functions to the Secretary of the Interior, however this will not require the DOE rules to be re-proposed.)

The Government can play a similar role in the domestic demand for coal. A switch to coal has historically been impeded by the significantly higher capital cost of the equipment to use this fuel, as compared with that for oil and gas. Today, however, the Economic Recovery Tax Act of 1981 should stimulate industrial and commercial users to switch to coal. Accelerated cost recovery should stimulate plant and equipment expenditures for new coal facilities by increasing a firm's cash flow. Capital costs of machinery and equipment and certain industrial and commercial buildings can now be depreciated over a period of 10, 5 or in the case of utility property, 15 years, rather than over the expected 20- to 30-year lifetime of the equipment as was previously required. The new tax law also relaxes Internal Revenue Service restrictions for leasing arrangements, thereby increasing the likelihod that investing companies can actually utilize available tax provisions.

The result should be a greater consumption of coal by users who will benefit from long-term fuel savings -- and thus be able to share those economic benefits with their customers.

In the environmental area, the Administration remains fundamentally committed to streamlining the current labyrinth of standards, regulations, permit procedures, data gathering, and other processes confronting coal producers and users. The question is not so much the stringency of regulations per se, as the uncertain and cumbersome nature of the regulatory process. A better balance can be attained between energy and environmental values without compromising public health and safety. Specifically, for concerns such as carbon dioxide (CO_2) and acid rain, a better understanding of their relationship to fossil fuel usage is needed before precipitous and possibly unnecessarily costly action is taken.

The potential climatic effects of CO_2 are the subject of recent widespread domestic and international concern. Atmospheric CO_2 accumulation is a global phenomenon, increasing with time, to which the U.S. is expected to contribute a declining share. Yet, the questions of CO_2 accumulation, its origins, and its impact on world weather trends remain unresolved, with substantial disagreement over whether a direct link can be made between CO_2 levels and fossil fuel consumption, and the magnitude of climatic change for any assumed CO_2 increase. The uncertainty is one of the driving forces for developing non-fossil technologies, however, fuel replacements in the U.S. have historically taken 60 years or more. Hence, fossil fuel usage is expected to continue at a high level for the next several decades. In the meantime, much work needs to be done to better understand -- and predict -- the effects of increased levels of CO_2 on climate and vegetation.

The current emphasis for action is on developing a better scientific understanding of CO_2 and its potential effects through a multi-agency research effort. The program is aimed at removing the substantial uncertainties associated with predicting or monitoring the effects of CO_2 from fossil fuel combustion. DOE's Office of Energy Research has the lead role in this multi-agency effort. Major participants include elements within the Department of Commerce (particularly the National Oceanic and Atmospheric Administration), the National Science Foundation, the Department of Agriculture, and the Department of the Interior.

Although on a different timescale, a better understanding of the acid rain phenomenon is also needed prior to making a decision on whether, when and how to control contributing pollutants. It is clear that precipitation acidity varies over a wide range and that the chemical composition of the precipitation is dependent on various factors such as emissions from utility and industrial boilers. Because the emissions are often transported long distances, the acid precipitation issue has assumed international significance both in North America and Europe. But there is still scientific uncertainty regarding the relative contribution of local and distant sources to acidic deposition. The U.S. Congress has, through the Acid Precipitation Act of 1980, mandated efforts to identify the sources and causes of acid precipitation, and evaluate its effects. The National Acid Precipitation Assessment Plan, now in the final draft stage, is an initial product of this Congressional mandate. It addresses the needs of the executive and legislative branches of government, industrial and environmental organizations, and the general public.

The U.S. has also signed a Memorandum of Intent with Canada to begin negotiations on the study and control of transboundary air pollution, including acid deposition. We believe a firm foundation of understanding should be developed first, to determine what measures would be necessary and effective in controlling transboundary air pollution. This need for fuller understanding is particularly important in view of the enormous cost of the existing technical approaches for controlling emissions.

In addition to conducting acid rain research and analysis programs, DOE, through the Office of Fossil Energy, has a role in conducting advanced, high-risk reseearch on energy technologies. A key research aspect in the Fossil Energy program is the development of new coal and other fossil fuel concepts that offer significant improvements in reducing the emission of pollutants such as sulfur and nitrogen oxides.

Technological Advancements

In connection with the anticipated growth in coal demand resulting from leasing, regulatory and tax changes, we must not overlook the fact that there is substantial opportunity for improvements in coal technology. The technology of direct utilization of coal by industrial and utility consumers has not changed significantly over the past 40 to 50 years. When coal was dominant over oil and gas, environmental regulations, and therefore environmental costs, were virtually non-existent, and capital and labor were relatively cheap. Matters are different now: capital is a primary cost concern, labor is expensive, and environmental controls can add as much as 25 percent to the ultimate cost of energy.

Under these circumstances and with the added stimulus of the recently-enacted tax incentives for industrial R&D, many energy users are intensifying their efforts to develop a new slate of coal technologies that can reduce transportation, capital and labor costs while simultaneously improving environmental quality. In turn, we are fashioning a Federal coal research program to complement these private sector initiatives. We are attempting to reorient the Government's activities to efforts that would not duplicate or compete with privately-funded projects. Our focus is on the leading edge of new technological concepts and on achieving a better understanding of the fundamental mechanisms at work in coal processes. The research to be funded with Federal dollars is that which industry will not perform because the payoffs, although potentially significant, are frequently difficult to predict, too far into the future, or not capable of being captured by individual firms.

In light of these criteria and particularly during a time of fiscal constraint, it becomes especially important to maintain active communication with the private sector. In this way, we can ensure that restructured Federal programs and priorities are compatible with the activities and needs of industry. With respect to coal, we maintain close coordination with such external groups as the Electric Power Research Institute, the research arm of the electric utility industry; the Gas Research Institute, which coordinates the research activities for the gas industry; the National Coal Association; the American Mining Congress; and various "user groups" (such as the Fuel Cell Users Group).

An example of how resurgent industrial activity in new coal technologies has resulted in a reshaping of the Federal program can be seen in the use of coal-liquid mixtures as fuels for utility and industrial boilers. In the late 1970s, the Federal government conducted a program to resolve the technical uncertainties of mixing coal with oil and burning the fuel as a replacement for oil. Based in large part on the results of this development effort, companies are now in a position to assess whether coal-oil mixtures make economic sense. At least 10 firms are already in the business of preparing and supplying coal-oil mixtures. Several utilities, principally along the East Coast, have conducted their own commercial-scale test burns. As a result of these private sector initiatives, the Federal program has moved away from research on coal-oil mixtures and toward longer-range, higher-risk fuels such as coal-water and coal-water-methanol mixtures -- fuels that can displace 100 percent of the requirement for oil but which still have sufficient risk to require more preliminary combustion research before they are accepted by the private sector.

The same type of cooperation with industry has been important in reshaping our "control systems" program, an effort which involves cleaning coal prior to its shipment and use (coal preparation), cleaning the combustion gases after coal is burned (flue gas and hot gas stream clean-up), and waste management. Today's commercial coal users are limited in their choices of coal cleaning methods. The economics of coal use could be improved if future plant operators could make trade-offs between a wider variety of coal preparation methods and flue gas clean-up. The choice would most likely be a combination. Consequently, we have oriented the Federal

research program to treat these technologies as successive interdependent steps, integrated with the final step of waste management. The objective is to establish a firm technology base so industry can make these trade-offs and thereby produce electrical or thermal energy at minimal costs and with significant reductions in environmental impact.

The first step in the "control systems" approach, coal preparation, is becoming increasingly important, expanding from its historical application in the metallurgical coal industry to a greater role in upgrading steam coal for utilities. The presence of significant amounts of ash in coal can lower boiler performance and reduce the time a boiler is available for service. Better quality coal, therefore, can improve boiler performance and increase availability, thereby permitting more electricity to be generated without the necessity for large capital investments for new power plants. The American Electric Power Service Corporation has estimated that if, by burning the proper quality coal and improving availability by 10 percent, utilities can recover some 19 million kilowatts of coal-fired capacity, as much as $15 billion to $20 billion can be saved in new facility construction costs today. The potential to maximize the use of existing, embedded capital by optimizing boiler availability has increased the pace of the private sector in developing improved ways to clean coal prior to combustion.

The DOE coal preparation program, in turn, is oriented toward an array of advanced technologies that reach beyond the shorter-range, lower-risk technical improvements now comprising industrial research investments. With these new cleaning concepts, the potential exists for upgrading the quality

of nominally "dirty" coals to levels rivaling fuel oil, as indicated by our preliminary laboratory development work. The advanced concepts emerging from this program, such as microwave and fused salt desulfurization, represent quantum leaps in traditional coal preparation technology. They could have the capability of producing from inferior U.S. coals, fuels with sulfur levels of less than 1 percent and ash levels less than 0.5 percent, while retaining the inherent economic competitiveness of coal.

Industry has also assumed much of the initiative in moving new flue gas desulfurization technologies -- or "scrubbers" -- into commercial practice, again in many cases, with the benefit of data from earlier research at Government laboratories. One example is the so-called "dry scrubber", which does not produce the caustic, difficult-to-handle wet sludge commonly generated by conventional scrubbers. This technology, originally considered an option only for low-sulfur western coals, was proven feasible for high-sulfur eastern coals in DOE laboratories. As a result, the concept is now gaining acceptance from equipment vendors supplying eastern coal users. Applied commercially, it is expected to reduce capital and operating costs of a flue gas scrubbing system by 15 to 25 percent. In addition, other Federally-sponsored activities to improve the conventional lime-limestone scrubber have created a substantial data base so that the private sector can assume the lead in the remaining development of nearer-term scrubber technologies. Consequently, the focus of Federal research has moved toward more advanced, higher risk concepts, such as systems which combine removal of SO_x, NO_x, and particulates from conventional coal combustors into a single unit.

Our program is also developing advanced hot gas clean-up technologies that will permit conversion devices, such as gas turbines and fuel cells, to retain the necessary durability when linked to coal gasification systems or to advanced coal burning systems such as pressurized fluidized bed combustors. In addition, advanced technologies to improve management practices for coal-derived wastes are being developed. Again, the results of our efforts are intended to flow into the research programs of the private sector, not to substitute for them.

As industry continues to look more toward coal, new boiler concepts, particularly the atmospheric fluidized bed boiler, could become increasingly attractive options especially for firing high sulfur or lower-quality coals. Fluidized bed boilers eliminate the need for costly sulfur dioxide removal equipment with the potential for saving perhaps 10 to 15 percent in overall generating costs compared to conventional boilers with scrubbers. Today, more than 35 industrial-scale atmospheric fluidized bed boilers are either operating or being built or designed. More are expected as companies take advantage of the new investment tax laws. One of the pioneer industrial fluidized bed boilers is operating nearby, on the campus of Georgetown University. This facility, now in its third winter of operation, is the product of a joint Federal/industry development effort. Based on both Government and private sector progress in developing this technology during the last decade, we believe industry is now ready to move on its own. Ten boiler manufacturers are currently involved in atmospheric fluidized bed technology; so again, the Federal program is shifting its focus to more advanced combustion concepts.

The emergence of more environmentally-benign, higher efficiency coal-burning technologies will be particularly important to realizing the near and mid term potential of coal. By the end of the century, at least 90 percent of the coal we use in this country will still be burned directly. The true "bottom line" is the cost and environmental impact of producing electricity or heat from coal, and we believe our program is structured to give industry the integrated scientific and engineering data base it needs to complete the development and commercialization of advanced technologies to produce energy from the direct combustion of coal at the lowest cost and with the least environmental degradation.

On the longer-term horizon is the potential for significant synthetic fuel production from coal, oil shale and other fuel sources. Here again, the Administration has reshaped the Federal program to be compatible with private sector activity. Historically, the Government's synfuels program proceeded along a continuum from basic research through large-scale engineering in pilot plants, eventually leading to planned commercial-scale demonstrations of the most promising technologies. Market conditions, however, have changed dramatically since this development sequence was first laid out in the 1960s and 70s. The price of world oil has increased several fold, improving the competitive posture of synthetic fuels. Controls have been lifted from the price of competing domestic oil, and proposals are being formulated to accelerate the deregulation of natural gas. Tax incentives are in place for industrial alternative fuel research, including synthetic fuels. And the Congress created an independent Government corporation -- the U.S. Synthetic Fuels Corporation -- to provide needed risk-sharing incentives.

The Synthetic Fuel Corporation's activities have been preceded by an interim program conducted by DOE and directed at those projects ready to begin immediate construction. Last summer, after personal consultations with the President, Secretary Edwards approved incentives for three synthetic fuel projects which met this criterion: a loan guarantee and a price guarantee respectively for two oil shale projects in Colorado and a loan guarantee for the Great Plains coal gasification project in North Dakota. These projects exemplify cooperative arrangements between government and industry which remove the financial obstacles that have stymied a synfuels industry in this country for nearly three decades, yet are expected to have minimum impact on the Federal budget.

The Great Plains consortium, a group of four natural gas pipeline companies, will receive a $2.02 billion loan guarantee for 75 percent of the construction costs of the synthetic fuel complex once final negotiations are completed most likely by the end of this month. One aspect of this government/industry cooperative effort is particularly important: by placing a substantial amount of their own private funds at risk plus sharing responsibility for cost increases up to $200 million and assuming full responsibility for any further increases, the corporate partners have the incentive to ensure that the project is conducted in adherence with sound business practices and as efficiently as possible. If current projections of actual process performance and world oil prices are reasonably correct, such "risk insurance" mechanisms as loan and price guarantees will minimize federal outlays while giving private financiers the assurances they need to invest in other first-of-a-kind projects.

These types of financial incentives have also been given the highest priority within the U.S. Synthetic Fuels Corporation which has assumed the lead federal role for assisting the commercial development of a U.S. synfuels industry. More than 60 firms applied to the Corporation following its first solicitation.

The Administration's actions in decontrolling conventional fuel prices and removing regulatory uncertainties will also provide synthetic fuel planners an environment in which sound business decisions regarding the timing and pace of this new industry can be made with a minimum of government intrusion.

As with direct combustion, the Federal research effort in synthetic fuels has been reoriented to complement private sector initiatives. The Government's role is viewed to be more properly at the start of the development path -- at the scientific and applied research stage and the first stages of engineering development. Where the questions become more of process development or of scale-up and economics, industry should be, and is, assuming the initiative.

Coal Exports

In 1979, the U.S. exported approximately 67 million short tons of coal and coke. About 23 percent, or 14 million short tons, was steam coal. In 1980, these exports had increased to 94 million short tons, of which 29 percent, or nearly 27 million short tons, was steam coal. U.S. coal exports in 1981, even with the miners' strike, are expected to exceed 100 million short tons, an amount comparable to the levels predicted for 1985 by several earlier studies. This sudden, sharp rise in U.S. coal exports can be attributed to extended coal mine strikes in 1980 in Australia and production

disruptions in Poland. The irregularity of Australian and Polish production and deliveries have led major coal importing nations to consider more permanent contractual arrangements with U.S. producers as a way of diversifying their sources of supply.

Historically, the primary U.S. coal exported has been metallurgical coal, not steam coal. In the future, however, steam coal will assume a dominant share of the U.S. export trade. While markets for U.S. metallurgical coal are expected to stabilize at roughly current levels, or about 60 million short tons, steam coal exports from the U.S. could grow at average annual rates of 8 percent or more.

Achieving this increase will require that U.S. suppliers keep their delivered price in a competitive range with other potential exporters, and that foreign buyers continue to find the U.S. a dependable source of supply. In this regard, the Administration issued its coal export policy statement in July which underlined the commitment not to interrupt coal trade under contractual agreement unless it was forced to do so by a severe national emergency. In any such event, the Administration is committed to working with our international trading partners to minimize adverse impacts.

The private sector is responding vigorously to ensure that the U.S. can take its appropriate place in the international coal market. Privately-financed improvement projects are now underway at more than 35 U.S. ports. Currently the U.S. has 143.8 million tons of coal export loading capacity. By 1985 these facilities could be capable of handling more than 230 million tons of coal exports. These expansions indicate that U.S. ports should have more than sufficient capacity by 1985-1990 to handle the volume of

export coal through the year 2000 if all potential handling facilities are developed. Additional investments are being made in mining, inland transportation, ocean transportation facilities, and port deepenings.

This significant private sector response is an important factor in fashioning the role Government should take in stimulating coal exports. The Administration has proposed legislation to recover through users fees the costs of port and channel improvements needed to accommodate increased trade; and the Administration is encouraging foreign participation in the improvement of facilities. At the same time, the Government, through the Coal Interagency Working Group, is continuing to examine ways to reduce delays in facility and system improvements caused by existing Federal regulations and permit-issuance procedures.

The Government can also serve as a catalyst in bringing together parties interested in U.S. coal exports to discuss solutions to potential obstacles. The DOE co-sponsored study recently completed by the Western Governor's Policy Office (WESTPO) on the future of western coal exports to the Pacific Basin is an example. The joint study process, involving Government, private sector, and state representatives, has established in both the U.S. and Pacific Basin countries an appreciation of the opportunities and challenges inherent in steam coal trade.

The Future for Coal

In any discussion of coal's future, it is worthwhile to set the scene with some basic, but sometimes overlooked facts.

Although coal offers a significant cost advantage over oil, these benefits must be balanced against the greater costs incurred in converting coal to electrical or thermal energy. Coal costs considerably more than oil to transport, store and handle. Its bulk and wide variability in many instances nearly doubles total capital investment requirements for combustion, heat transfer, and environmental management. And operating and maintenance costs are considerably higher with coal than with oil or gas.

On the other hand, the U.S. has a large domestic coal resource base, and there is sufficient competition within the coal industry to constrain non-production associated price increases in the foreseeable future.

Since more than 80 percent of coal use today in the U.S. is by the electric utility market, and since large coal utilization facilities take from 7 to 10 years to build and are designed for lifetimes of 30 years or more, the bulk of coal produced in the next decade or two will continue to be used in much the same way it is used today. Significant factors governing coal's future growth in the next 10 to 20 years, therefore, will be the anticipated levels of electrical demand and the interest rates charged for utility investments. Capital costs continue to escalate for all new power plants, including both coal and nuclear, due to high inflation, high interest rates, and increasingly long construction periods. Under these conditions, many utilities are not in a position to finance new multi-billion dollar plants. Therefore, perhaps few sectors of our economy stand to benefit more from the Administration's program to lower interest rates and shorten the time for regulatory approval than utilities.

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Today's trend is toward the use of coal in large boilers. Even though smaller units are exempted from many environmental control standards, they nonetheless are subject to less favorable economies of scale. For medium-size boilers which fall under environmental control regulations, the costs of compliance must be coupled with the economic disadvantages of scale. This could cause many medium-size boiler operators to think twice about investments in coal equipment, even though substantial savings would be achieved in overall fuel costs. Several options exist to overcome this obstacle, and it is here where the new coal technologies may have the earliest market penetration. Coal cleaned to superior qualities, perhaps delivered in a slurry with either oil or water, might be one approach. Fluidized bed combustion might be another. Coal gasification could be a third. The key is to develop a sound technology base, then let the market be the ultimate judge.

The marketplace will also be the ultimate test of the commercial viability of a synthetic fuels industry. The Government's objective should not be to foster such an industry indefinitely, but rather to establish a firm base of diversified commercial experience, undergirded by a sound advanced research program, from which a durable industry can grow if market conditions warrant. We're convinced that there is a long-term role for coal in the production of liquid and gaseous substitutes for conventional hydrocarbons, although the pace and composition of such an industry will be more properly determined by market factors.

Projections for Coal — Not Predictions

Today, meaningful projections of energy supply and demand, including coal, are clouded by the economic, social, political and regulatory environments in which we must operate. As long as supply and demand are both included and price assumptions are made clear, carefully prepared projections are useful in cross-checking the feasibility of national energy policy. Yet even the traditional "best estimate" projection is not a prediction. Projections cannot and should not be used as a blueprint for the future. In July, 1981, the Department presented to Congress the National Energy Policy Plan, which underscored the uncertainties of making projections although acknowledged their value as a means of anticipating prospective problem areas. The following tables summarize the Policy Plan's projections of U.S. energy consumption and production:

ENERGY CONSUMPTION
(Quadrillion Btu's Per Year)

		PROJECTED[1]					
		1985		1990		2000	
	PRELIMINARY[2] 1980	Midrange	Range[3]	Midrange	Range[3]	Midrange	Range[3]
CONSUMPTION BY SECTOR							
Residential	10.7	10.7	10-11	10.6	10-11	10	9.1-11
Commercial	7.3	7.3	7.0-7.5	7.8	7.3-8.3	8.5	7.8-9.3
Industrial	23.7	25.4	25-26	27	25-29	31	28-34
Transportation	18.6	18.2	18-19	18	17-19	18	17-20
End-Use Consumption	60.3	62	60-64	63	59-67	68	62-74
CONSUMPTION BY FUEL							
Direct Oil[4]	31.2	29	28-30	27	26-29	24	23-25
Direct Gas[5]	16.7	17	17-17.5	18	17.5-18.5	20	18-22
Direct Coal	3.5	4.7	4.4-5.0	5.5	5.0-6.4	7.5	6.6-8.2
Direct Renewables	1.8	2.1	2.1-2.2	2.7	2.6-2.8	4.2	3.9-4.5
Electricity[6]	7.1	8.3	7.8-8.8	9.6	8.5-11	12	10-14
End-Use Consumption	60.3	62	[illegible]-64	63	59-67	68	62-74
Conversion Losses[7]	17.7	20	1[illegible]-21	24	21-27	32	28-36
TOTAL CONSUMPTION	78.0	82	79-[illegible]5	87	80-94	100	90-110

[1]Totals may not add due to rounding.
[2]Residential, commercial, and industrial consumption based on preliminary 1980 data adjusted to reflect 1973-1978 trends. Transportation consumption from Energy Information Administration, Monthly Energy Review, March 1981. Includes 1.8 quads of biomass not included in DOE/EIA statistics.
[3]Range comes from varying GNP assumptions (see Table 3).
[4]Includes liquid synthetic fuel from coal.
[5]Includes synthetic gas from naphtha and coal.
[6]Net electricity generated from coal, nuclear, oil, gas, renewable, and hydroelectric powerplants and delivered to final consumers.
[7]Includes losses of energy in the production, transmission, and distribution of electricity, plus losses in the production of synthetics from coal (a relatively minor portion of the table within this time period).

TABLE 2

ENERGY PRODUCTION[1]
(Quadrillion Btu's Per Year)

		PROJECTED					
		1985		1990		2000	
	ACTUAL 1980	Midrange	Range	Midrange	Range	Midrange	Range
DOMESTIC PRODUCTION							
Oil and NGL[2]	20.5	18	17-20	18	16-21	20	17-24
Natural Gas[3]	19.8	18	17-19	18.5	16-21	18	14-21
Coal[4]	18.9	22	20-23	27	24-30	42	37-45
Nuclear	2.7	5.5	4.9-6.2	7.6	6.7-8.7	10.6	7.4-14
Hydro/Geothermal[5]	3.2	3.4	3.2-3.6	3.6	3.3-3.9	4.3	3.7-4.9
Renewables[6]	1.8	2.2	2.0-2.4	2.8	2.4-3.3	5.4	3.9-7.0
Subtotal[7]	66.9	69	64-75	78	68-88	100	83-116
NET IMPORTS							
Oil	13.3	13	10-18	10	4-15	3	0-11
Gas	1.0	2	1-3	2	1-3	2	1-3
Coal	(2.4)	(2.7)	(2.0-3.1)	(3.5)	(2.3-4.3)	(5.9)	(3.4-8.4)
TOTAL CONSUMPTION[8]	78.0	82	79-85	87	80-94	100	90-110

[1]Ranges reflect uncertainties in key assumptions, which are detailed in *Energy Projections to the Year 2000* (DOE/PE-0029).
[2]Includes shale oil, but excludes coal liquids.
[3]Excludes synthetic gas from coal and naptha.
[4]Includes coal production for synthetics and coal exports.
[5]Includes about 0.2 quads of imported hydroelectric power.
[6]Renewables include about 1.8 quads of biomass not presently part of EIA/DOE statistics.
[7]Totals may not add due to rounding.
[8]Range in projections of total energy consumption (rounded to the nearest quad) results from varying GNP assumptions. Total consumption for 1980 includes 0.8 quads of net stock increases; zero stock change assumed in 1985 and beyond.

While the current projections are consistent with recent projections prepared by other government and private groups, the future is far more uncertain that these or any other projections might indicate. Factors such as the world oil market and the behavior of the economy have proven to be unpredictable, even in the near term. The most one can expect from these projections is an appreciation of potential trends in energy supply and demand patters, and their sensistivity to key uncertainties.

Summary

In short, there are challenges confronting the coal industry in this country, but there are no practical obstacles that cannot be overcome. We believe the best way to meet these challenges is for the Government to:

(1) control inflation which threatens the value of the Nation's currency and hinders investment in industrial expansion;

(2) return to private industry the responsibility to read marketplace signals free of unnecessary Government demands and fluctuations in Federal regulations; and

(3) maintain a core program of Federally funded, high-risk, long-term research with high potential for payoff to ensure that new concepts continue to enter the industrial R&D investment pipeline.

I will be pleased to answer any questions the Committee may have.

Representative REUSS. Thank you, Mr. Mares.

I think we'll hear from all witnesses and then ask some questions.

We'll next hear from Mr. Eugene Samples of the Consolidation Coal Co. and chairman of the National Coal Association.

STATEMENT OF R. E. SAMPLES, CHIEF EXECUTIVE OFFICER, CONSOLIDATION COAL CO., PITTSBURGH, PA., AND CHAIRMAN, NATIONAL COAL ASSOCIATION

Mr. SAMPLES. Thank you, Mr. Chairman.

As you stated, I'm appearing here before the committee as the chairman of the National Coal Association, also as a representative of the American Mining Congress.

Mr. Chairman, it's my privilege to present what I think is the coal industry's role in helping our Nation to rebuild its industrial strength and, with the cooperation of Government, to achieve a more important goal—and that's improving the American people's standard of living and contributing to social progress. Both things are fundamental to the continued success of this domestic society, I believe.

The coal industry has long been a working partner with Government and the business sector in working toward economic progress, both as a major employer and consumer and by supplying competitively priced energy to our total economy.

Today I think we're living in a new energy era, triggered in large part by the oil price shocks that came during the 1970's, but I think, more importantly, ushered in by the shift from declining real energy costs to what we now have, rising real energy costs.

The new energy era demands that the United States use its vast domestic energy resources wisely and effectively, and that's not just to bring about a new industrial, economic revival, but also to protect our national security.

Greater use of American coal will reduce the dependence of the United States and its allies on Mideast oil. This would put us in a stronger position both diplomatically and strategically. We are all aware of the dangers that the Western Alliance faces in relying on a thin line of tankers that threads its way through the volatile Persian Gulf. This energy lifeline could be cut off at any time.

Of course, I would like to envision an alternative, which would be a fleet of coal carriers spreading out throughout the world from our eastern and western ports, carrying our coal products.

INDUSTRY READY FOR COAL CHALLENGE

I want to assure this committee that a new coal industry is standing ready to meet the challenge of the new energy era. Our industry has the production capacity and the technological ability to help our Nation recapture its energy leadership position and to lend a helping hand to our allies, whose economic progress and political stability I think are so important to our own.

This morning I want to briefly explain why we in the coal industry believe coal should be America's primary fuel choice and why American coal can be a crucial tool in helping to restore economic progress, not only for ourselves but for the free world.

We believe that coal offers an important economic opportunity, not just in the years immediately ahead, but for generations. In our battle

to rebuild our industrial strength and to rekindle the fires of economic growth, our foremost enemy is uncertainty.

If investors in our country or in the world, for that matter, can't make proper economic decisions. Then sound future planning is just virtually impossible.

I am sure that the committee will agree that the nagging unanswered questions about energy, price, and supply have been primary contributors to the economic uncertainty in our recent years.

Today, oil and natural gas supply three-quarters of our energy needs. These fuels will continue to be higher in price, shorter in supply, and will increasingly be needed as feedstocks for thousands of alternative essential products.

I think these points have been hit by Mr. Carroll Wilson earlier. What's more, even though our economy is stagnating, we are still importing several million barrels of oil a day. Last year we spent about $80 billion on it. These dollars could have helped to create American jobs and to feed our investment in economic and energy development.

Without question, vigorous efforts are needed to maintain oil and gas production, but these efforts must take into account that oil and gas must be competitively priced to insure that our economic prospects are brightened and not dimmed.

At the same time, coal, our most abundant domestic fuel, can be produced at relatively constant real prices over a long time—and we heard earlier reference to that—roughly at half the price of oil at the present time. Coal production could easily double without any appreciable real price increase, and the reasons are pretty simple.

COMPETITION AND PRODUCTION

The United States huge reserves are readily available and can be mined with an established technology. The competition is fierce among the more than 3,000 coal companies vying for a share of the market. This creates a favorable atmosphere for continued long-term price stability. A coal-based, national energy supply, used to generate electricity or directly in the industrial process, in sharp contrast to an economy heavily dependent on oil and gas, carries with it the prospects of strongly moderating the real price of all energy, which history has shown is essential to sustain economic growth.

Competition and production at stable real prices means that all Americans will receive these benefits, regardless of what happens to the price of oil and natural gas. I think these are coal's overall positive prospects, but coal also can be a critical element in helping to restore productivity, which is, I'm sure, of grave concern to this committee, as it is to all of us. By using more coal and by taking full advantage of its stable price, coal can be a powerful force in keeping production costs under control; and they certainly aren't nowadays. And therefore, you can further economic growth.

President Reagan's economic recovery program correctly seeks to stimulate more investment in plant expansion and a new industrial development. We believe that the moderating effects of stable energy prices achieved with more coal use can make more capital available for investment.

Lower relative energy costs can help the average consumer by lowering energy bills. Lower energy costs will help to make room in the

family budget for more savings, which ultimately may be reinvested in industry.

Of equal concern to the economy is energy efficiency. We must produce more goods and services by using less energy. Again, coal has advantage through conversion to electricity. More coal-generated electricity can lead to much greater efficiency in those industries which are not electricity intensive.

Coal's value as an oil and gas substitute in electric generation is compelling. In 1980, about 2.7 million barrels of oil and gas equivalents were used each day to generate electric power. By substituting oil and gas with coal, we clearly are heading toward energy sufficiency and we're also improving industrial efficiency, lowering consumer costs, and enhancing environmental quality as these new coal plants that burn coal replace older, more polluting, oil-fired plants, nor can we forget that American coal exports overseas are also proving to be a strong economic weapon and a hedge against the political uncertainties of free world oil dependence.

American coal is already becoming the economic common denominator of the growing interdependence between the United States and the other nations of the world. These nations are looking toward the West for a sustained supply of reasonably priced energy, which is unfettered by the pricing and production whims of the oil-producing nations.

By sending more coal abroad we're adding billions of dollars to our balance of payments. By century's end, we expect coal to become a leading export commodity, with an annual trading value of $14 billion. That's pretty consistent with what Mr. Wilson said before.

This, of course, discounts the billions of dollars of spinoff economic benefits that would accrue to our economy all along the mine-to-market coal chain. Coal prices are directly related to how efficient and competitive the mine-to-market system is maintained. I want to emphasize that mine-to-market efficiency and competition cannot be maintained without diligent cooperation between our industry and the Government. That's why the coal industry is here today supporting public policy changes that can help remove coal's constraints.

CRUCIAL POLICY CHANGES

Now, let me cite a few of the policy changes that are crucial and very important to coal and also explain why we need the cooperation of the Congress to make them possible.

The United States has enough coal to supply our energy needs for generations, but that supply must be available for future use. That is why it is so important for the leasing of Federal lands—of which 80 percent are now owned by the Federal Government—to move ahead rapidly.

We are encouraged by the Department of the Interior's steps to reopen Federal coal lands for lease and to streamline the coal-leasing process. But let me repeat, we cannot forget that the energy plans that we make now, today, are what we're going to live with tomorrow and in the future. So, we need to get on with the leasing.

Now, an efficient, competitive coal transportation system is crucial to coal's price stability. We have already a sophisticated system, but it needs improvement, not just to pump more coal into America's economic mainstream, but to insure that coal has some price stability.

The rates charged for coal transport by the railroads are of serious concern to us. This concern should be shared by all energy consumers; 65 percent of all coal produced in this country is moved by rail, and 85 percent of the railroad coal traffic has no practical alternative—in other words, it's captive.

The Staggers Rail Act of 1980, which we supported as an industry and still support, provides the mechanism to keep captive coal rates in line. But recent Interstate Commerce Commission rulings have subverted the intent of Congress. If these rulings stand, it could have serious negative consequence for our consumers' pocketbooks.

Electrical utilities are using 80 percent of all coal production, and transportation costs generally make up a very large portion of cost per ton delivered.

As others have mentioned, granting coal slurry pipelines the right of eminent domain offers a sure way to give the railroads the needed competition for coal markets. The savings from this increased competition will be passed on to the consumer.

Legislation is now pending to give this transportation alternative the same eminent domain rights as oil and gas pipelines and electric transmission lines. If this legislation isn't passed, coal slurry pipeline construction will remain mired in legal battles, and we will likely lose a sterling opportunity to build badly needed competition into our coal transportation system.

Improvements in our inland waterway system and ports are also urgently needed. And this has been mentioned previously. Waterways provide a low-cost means of moving coal to the market, and there are many log jams at crucial locks and dams. These roadblocks cannot be removed and construction of new facilities speeded up unless we cut the redtape and find an equitable way to finance that construction.

The coal industry is already on record in support of a system of cost sharing of lock and dam improvements, but we need public policy changes to make this a reality.

In the same way, our harbors have to be dredged to take advantage of the lower transportation costs made possible by larger coal-carrying ships. These vessels can save as much as 40 percent on transportation of coal overseas.

Lower ocean transport costs will assure that the United States remains competitive with other coal-exporting nations. The coal industry is willing to share these costs, and private industry is also willing to take over the construction responsibilities from the Federal Government. But an acceptable cost-sharing plan must also be accompanied with a fast-tracking of permitting, if we're going to get the job done.

Today, permitting is moving at a glacial pace and in some instances holds up dredging projects for two decades. So, we desperately need some speed.

Natural gas also must be deregulated to help energy planners make the proper economic decisions. I think our energy history is pretty clean. A regulated energy market produces shortages, higher prices, and economic dislocation, regardless of the short-term appeal. Coal wants only to compete with other fuels equally in the marketplace, and gas deregulation will make this possible.

The Clean Air Act is a good law. Some discussion of it has been had, but it certainly needs to be streamlined. After 10 years of experi-

ence, it's clear that the act is too complex, overly stringent in its application, and it's having an adverse effect on economic development.

We believe that changes can be made that will spur coal use and will protect people's health, and it will certainly lower energy costs for the consumer.

In summary, Mr. Chairman, American coal can be a crucial tool toward supplying this Nation with a sustained supply of reasonably priced energy. And I think, as I stated before, this is very essential to economic growth. A stable energy supply can remove economic uncertainty by controlling the cost of production and creating more investment opportunities for business and the consumer.

With coal's leadership, we can move our Nation full speed ahead toward restoring economic health and preserving a healthy economy in the future. There is no logical reason for this Nation to continue to be subject to the whims for foreign oil producers. Likewise, there is no reason for this country to be subject to the volatility of Middle East politics.

I think the coal industry is ready to meet the challenge, and we look forward to full cooperation with the Congress, in those areas that we need their help, to make these goals a reality.

Thank you, Mr. Chairman.

Representative REUSS. Thank you, Mr. Samples. We'll now hear from Mr. Russell Train.

STATEMENT OF RUSSELL E. TRAIN,[1] PRESIDENT, WORLD WILDLIFE FUND

Mr. TRAIN. Thank you, Mr. Chairman. With your permission, I will leave out some of the introductory part of my prepared statement. But before you become enthusiastic over that, I will add that since I learned of the committee's interest in the CO_2 problem, I have added a few comments at the end on that subject.

Representative REUSS. We're grateful to you. The full prepared statement will be in the record. Concentrate on whatever you'd like.

Mr. TRAIN. The world coal study, in which I participated, summarizes its conclusions in the area of environment health and safety as follows: Coal can be mined, moved, and used in most areas in ways that conform to high standards of health, safety, and environmental protection by the application of available technology and without unacceptable increases in cost.

The present knowledge of possible carbon dioxide effects does not justify delaying the expansion of coal use. The report bases this general conclusion, as Professor Wilson has outlined, on its finding that applying the highest environmental control costs which can be expected to the market price of coal still leaves it substantially cheaper than its energy equivalent in oil and certainly fully competitive with other fuels.

I concurred with this conclusion at the time of the report and have no information that would lead me to change my opinion at

[1] Former Administrator, Environmental Protection Agency, 1973–77; participant, World Coal Study (WOCOL), 1979–80.

this time. My prepared statement points out that a number of other groups have reached generally similar conclusions in recent months.

Nevertheless, Mr. Chairman, before we become carried away by the guarded optimism of the World Coal Study, it is important to keep emphasizing that its conclusion that the use of coal can be substantially increased at acceptable environmental health and safety costs is premised on the assumption that high standards will be applied and forced.

There is no suggestion whatsoever that significantly increased use of coal can be achieved at the same time as standards are relaxed, or their implementation is not vigorously pursued. Indeed, it has always been my view that we would never significantly increase the use of coal until and unless high standards of protection were in fact maintained. It would be the worst possible form of self-delusion to believe that we can do so.

POLICIES OF EPA, INTERIOR

I point out in my statement that some recent policies of EPA and the Department of the Interior do not reassure me that the foundations of the study's environmental conclusions will remain valid. These actions may erode the prospects for large increases in future coal production and uses.

Let me quickly discuss several of these. EPA has proposed regulations that would allow more existing powerplants to use tall stacks to disperse air pollution instead of investing in environmental controls or coal cleaning to reduce it. This proposed change in policy would affect the Nation's largest, dirtiest, coal-fired powerplants.

Second, EPA proposed to study acid rain instead of taking steps to stabilize or reverse the problem. The evidence seems quite clear that small sulfate and nitrate particles are raising the acidity of many of our lakes and that SO_2 and NO_x emissions are the precursors of these sulfates and nitrates.

While it is true that we do not know which emissions from which sources wind up in which lake, I believe we do know enough to do more than fast study the problem further. We know that the acid increases are greatest in the Northeast, downwind from the Nation's largest concentration of powerplants including some of the worst polluting ones. Failure to deal with acid rain will only increase, in my view, the long-term resistance to the use of coal.

Third, EPA has canceled its program to provide technical guidance for the permitting of synthetic fuel plants and virtually eliminated the research necessary to define the health risks of synfuel plants and the technologies that can reduce those risks at reasonable cost.

The World Coal Study acknowledged the paucity of data about emissions from synfuel plants and called for joint international action. Now, EPA has stepped back leaving industry, all permitting authorities, and the courts faced with enormous uncertainties they cannot resolve themselves.

EPA has slowed or halted development of new source performance standards for coal-fired, industrial boilers. The current standards only apply to very large boilers. If industry starts shifting to coal-fired boilers, as we had hoped, and their neighbors suffer, coal may suffer an expensive public black eye.

The Interior Department appears to have slowed implementation of the Surface Mining and Reclamation Act, particularly through reorganizations, reassignments, and dismissals. Here again, new policies may tend to limit public acceptance of the increased use of coal.

Therefcre, Mr. Chairman, I am reasonably optimistic that the use of coal in this country could be significantly increased consistent with high standards of environmental health and safety protection. But I see less grounds for optimism that we will in actual practice adopt, maintain, and pursue the policies that will make this possible.

Let me just add on that last comment that I am not talking about economic or technical feasibility in terms of increasing substantially the use of coal. The point I'm making is that in my own view, the public acceptance of the use of coal, particularly the increased use of coal, turns very much upon the maintenance of high standards. And here is where my concern has always been. The apparent present trend simply reinforces those concerns.

THE ISSUE OF CO_2

On the CO_2 matter, there does appear to be a growing body of scientific opinion that the problem of CO_2 released to the atmosphere from the combustion of fossil fuels is a serious one. I certainly concur with Carroll that there is no unanimity about the matter.

I also hasten to add, I am not a scientist, as you know, Mr. Chairman. And so all I can do is reflect what I hear. You would have to turn to others to really provide you objective scientific opinion.

Nevertheless, projections given me, based on present utilization of fossil fuels and assuming a continuation of the present rate of growth worldwide in the use of such fuels of between 2 and 2.25 percent, suggest a doubling of the global atmospheric loading of carbon by around the middle of the latter part of the next century. Such doubling could be expected to raise the average global temperature by about 2° centigrade with progressively greater increases as you move toward the poles. There may be some argument over the 2°. I don't think there is any argument over the fact that the temperature effect will be greater in the higher latitudes.

Thus, the temperature increase in the Northern part of the United States, including the great grain belt of the Midwest, would be, I am informed, in the neighborhood of 5° centigrade, with an accompanying sharp reduction in rainfall.

And here's where you begin to get the rather scary projections such as cutting in half the volume of flow of the Colorado River and being aware of the fact that everyone is fighting today over every ounce of water in the Colorado, one wonders how one would deal with a reduction in flow of that magnitude.

Two aspects of this problem have a particular bearing on the subject of today's hearing. First, the combustion of coal produces more carbon than does either oil or gas. Second, energy systems, once put in place, cannot be quickly dismantled.

These considerations do suggest that we not permit world economies to become hooked on the use of coal. They also tend to give far greater weight, in my mind, to the importance of alternative nonfossil sources of fuel energy and to the vital role that the conservation of

energy can have in reducing the rate of increase in the CO_2 problem and providing society with the time with which to bridge the period until alternative energy sources are more generally feasible and available.

An important aspect of this problem, and one with which the World Wildlife Fund is particularly concerned, is the fact that about one-half—well, an amount equal to atmospheric loading of carbon—is locked up in the forests of the world, both the tropical and temperate forests. And the significance of this fact is in turn related to the fact that tropical forests in particular are being eliminated at a rate which suggests that they will be largely gone by the middle of next century.

Let me add one more point: It has been pointed out that the impact of major temperature increases may tend to be very adverse on the agricultural productivity of the United States and China, but perhaps beneficial to the Soviet Union. All three of these nations also happen to be the location of the world's principal reserves of coal.

All these considerations serve to underline the need for the United States—getting off now on one of my own personal kicks at the moment—to develop a far better capability to carry out long-term analysis and strategic planning concerning such local resource issues. Our capability in this regard is woefully inadequate at the present time.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Train follows:]

Prepared Statement of Russell E. Train*

Mr. Chairman and members of the Joint Economic Committee:

I appreciate this opportunity to testify concerning the potential of coal in meeting future energy needs. My remarks will be limited to and directed to the environmental implications of expanded coal use.

As we know, the use of coal is associated with a wide range of environmental, health, and safety impacts in both its production (including deep mining, surface mining, and synfuel conversions) and its utilization. While uncertainties remain as to the exact nature and magnitude of some of these impacts, requiring a continuous research effort in order to reduce those uncertainties, there can be no question that the uncontrolled production and utilization of coal would have significant adverse impacts on human health, environment, and safety. I think it may also be taken as a given that any expansion of the production and utilization of coal, assuming a constant level of controls, would result in an increased level of those adverse impacts.

The World Coal Study (WOCOL) in which I participated concludes that most of the environmental risks from coal use are amenable to technological control.[1]

The principal areas of concern, as summarized by the study, include land reclamation after surface mining; subsidence from underground mining; acid drainage from the refuse from coal mines

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* Former Administrator, Environmental Protection Agency (1973-1977); participant, World Coal Study (WOCOL)(1979-1980).

1. For a detailed discussion of the environmental, health, and safety aspects of the study, see "COAL--Bridge to the Future," Report of the World Coal Study, Ballinger Publishing Company (1980), pp. 133-155.

and coal preparation plants; emissions from combustion such as SO_2, NO_x, and particulates; safe disposal of ashes; and the possible effects of CO_2 on climate. The applicability and priority of these concerns vary from country to country depending on a number of circumstances. The report goes on to state:

> "Except for the CO_2 question, however, technology is available to meet these concerns and to comply with the most stringent of the current environmental standards in each WOCOL country at costs that leave coal competitive with oil at mid-1979 prices in most areas. There is no practical method of controlling CO_2 emission from the combination of fossil fuels and from other sources, and further research is needed on the possible effects of increased CO_2 emissions on global climate. Control of long-range transport of gaseous and particulate emissions may also require new forms of international cooperation."[2]

Finally, the Report summarizes its conclusions in this area as follows:

> "Coal can be mined, moved, and used in most areas in ways that conform to high standards of health, safety, and environmental protection by the application of available technology and without unacceptable increases in cost. The present knowledge of possible carbon dioxide effects on climate does not justify delaying the expansion of coal use."[3]

The Report bases this general conclusion on its finding that applying the highest environmental control costs which can be

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2. Ibid., p. 27

3. Ibid., p. xvii

expected to the market price of coal still leaves it substantially cheaper than its energy equivalent in oil and certainly fully competitive with other fuels. I concurred with this conclusion at the time of the Report and have no information that would lead me to change my opinion at this time.

I might add that contemporary studies by other, diverse, high-level groups have reached generally similar conclusions, including Professors Yergin and Stobaugh at the Harvard Business School,[4] the Committee on Nuclear and Alternative Energy Systems of the National Academy of Sciences,[5] a Ford Foundation Study Group,[6] and the National Commission on Air Quality.[7]

Nevertheless, Mr. Chairman, before we become carried away by the guarded optimism of the WOCOL study, it is important to keep emphasizing that its conclusion that the use of coal can be substantially increased at acceptable environmental, health, and safety costs is premised on the assumption that high standards will be applied and enforced. There is no suggestion whatsoever that significantly increased use of coal can be achieved at the same time as standards are relaxed or their implementation is not vigorously pursued. Indeed, it has always been my view that we would never significantly increase the use of coal until and unless high standards of protection were, in fact, maintained. It would be the worst possible form of self-delusion to believe that we can do so.

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4. R. Stobaugh and D. Yergin, Energy Future 91-94 (1979).

5. Committee on Nuclear and Alternative Energy Systems, National Academy of Sciences, Energy in Transition 1985-2010 146-49 (1979).

6. H. Landsberg et al., Energy: The Next Twenty Years 327-29 (1979).

7. National Commission on Air Quality, To Breathe Clean Air 2.1-87 to -95 (1981).

Recent policies of the Environmental Protection Agency and the Department of the Interior do not reassure me that the foundations of the Study's environmental conclusions will remain valid. These actions may erode the prospects for large increases in future coal production and uses. Let me quickly discuss several of these concerns:

- The EPA has proposed regulations that would allow more existing power plants to use tall stacks to disperse air pollution instead of investing in environmental controls or coal cleaning to reduce it. This proposed change in policy would affect some of the nation's largest, dirtiest coal-fired powerplants. The policy is uneconomic: these plants could reduce their SO_2 emissions at a cost of $200 per ton, whereas the average cost of SO_2 reductions is $460 per ton, and new plants pay as much as $1000 per ton. By excusing the plants that could reduce sulfur loadings (and therefore acid rain) at the lowest cost, this proposal will increase the overall cost of cleanup. It will also make coal harder to use in the future because ultimately new coal-fired plants will face higher cost controls--and probably also renewed citizen resistance to "dirty" coal facilities.

- EPA proposed to study acid rain instead of taking steps to stabilize or reverse the problem. The evidence seems quite clear that small sulfate and nitrate particles are raising the acidity of many of our lakes and that SO_2 and NO_x emissions are the precursors of these sulfate and nitrates. While it is true that we do not know which emissions from which sources wind up in which lake, I believe we do know enough to do more than study the problem further. We know that the acid increases are greatest in the Northeast, downwind from the nation's largest concentration of power plants, including some of

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the worst polluting ones. We know that power plants emit about 65% of the SO_2 and about 31% of the NO_x emissions. We know that acidity is starting to increase in Eastern lakes, coincident with the increase of urban and industrial growth there. We should not remain idle while the problem worsens. We could, for example, reduce utility SO_2 emissions by 25%--five million tons per year--for about $200 per ton, roughly one-fifth the cost of a ton of sulfur removed from newer sources. Failure to deal with acid rain will only increase resistance to the use of coal.

- EPA has cancelled its program to provide technical guidance for the permitting of synthetic fuel plants and virtually eliminated the research necessary to define the health risks of synfuel plants and the technologies that can reduce those risks at reasonable cost. The World Coal Study acknowledged the paucity of data about emissions from synfuel plants and called for joint international action. Now EPA has stepped back--leaving industry, all permitting authorities, and the courts faced with enormous uncertainties they cannot resolve themselves.

- EPA has slowed or halted development of new source performance standards for coal-fired industrial boilers. The current standards only apply to very large boilers. If industry starts shifting to coal-fired boilers as we had hoped, and their neighbors suffer, coal may suffer an expensive public black eye.

- The Interior Department appears to have slowed implementation of the Surface Mining and Reclamation Act, particularly through reorganizations, reassignments and dismissals. Here again, new policies may tend to limit

public acceptance of increased use of coal.

Therefore, Mr. Chairman, I will conclude by saying that I am reasonably optimistic that the use of coal in this country could be significantly increased consistent with high standards of environmental, health and safety standards, but I see less grounds for optimism that we will in actual practice adopt, maintain and pursue the policies that will make this possible.

Representative REUSS. Thank you, Mr. Train.
Now, we'll hear from Mr. Wearly.

STATEMENT OF WILLIAM L. WEARLY, CHAIRMAN OF THE EXECUTIVE COMMITTEE AND DIRECTOR, INGERSOLL-RAND CO., WOODCLIFF LAKE, N.J., ON BEHALF OF THE AMERICAN MINING CONGRESS

Mr. WEARLY. Chairman Reuss, I am here today representing the American Mining Congress and machinery and equipment manufacturers.

I believe I will be able to convince you that coal's growth is highly dependent on the availability of more productive equipment and that availability of equipment is considerably hampered today by roadblocks inadvertently placed by the Government.

My comments will cover chiefly technical and economic aspects of coal mining and coal burning. Please be assured that our problems today do not involve limitations in manufacturing capacity.

It is obvious, though, that production of mining equipment will have to increase and employ more workers. I think we all agree about that. Let's talk about machinery used in the production of coal where the key word is "productivity," or how many tons of coal a man can mine in a work shift.

THE IMPORTANCE OF PRODUCTIVITY

Productivity is very important for two reasons: Safety to the miner and the relative cost of labor. In 1980 approximately 273,000 miners produced America's 824 million tons of bituminous coal. Productivity was 15.09 tons per man-shift. Just make a mark at that 15, because we need to remember it.

Increasing productivity in tons per man-shift reduces the amount of time that man must be exposed to the hazards of mining to be able to produce a ton of coal. Thus, safety is improved.

Second, the cost of manual power which is already much higher than mechanical power continues to escalate while mechanical power costs are declining. Let's not forget that coal's current attractiveness is due in large part to its relative price stability brought about during the last 40 years by many infusions of more productive mining methods: First, from hand mining to mechanized mining in the early 1940's; then from track to trackless mining in the 1950's; then to continuous mining machines in the 1960's; to huge open pit operations in the 1970's; and now to Longwall mining.

The productivity increase in coal mining, this is remarkable. It rivaled that of agriculture as one of America's greatest achievements. From less than 3 tons per man-shift in the early 1930's, coal productivity reached 19.9. Write that down. Just call it 20 tons per man-shift, the highest in the world, in 1969.

Then the introduction of the Coal Mine Health and Safety Act devastated it. I'm not taking a position on these things, but I'm merely trying to state what happened and what we might do about it.

After the Coal Mine Health and Safety Act of 1969 the cost of coal began escalating. The next 10 years saw a 47-percent reduction in productivity and a 380-percent increase in coal's selling price. It is interesting to speculate what that price might have been had not we

had the great improvement in productivity earlier. It would be far less attractive today. We must continue, however, with machinery development and I think this will happen and will contribute to the revitalization of the industry.

THE USE OF COAL

Now, I've mentioned only coal production. Let's shift for a little bit to the use of coal. Since 70 percent of coal usage is electric power, I'll use power generation as my example. Here the key word is heat rate, how many Btu's are used per kilowatt-hour generated. Heat rate is the efficiency term in coal burning, just as productivity is the efficiency term in coal mining.

Heat rate showed continuous improvement over the past 30 years and in fact by 1966, 27 percent less coal was required to produce a kilowatt than it was in 1950. Combustion technology and better equipment contributed to this by moving to higher pressure boilers. Not only was 27 percent less coal required, but the boiler plants became smaller, lighter and gave efficiencies of scale.

Heat rate improvement, however, met its Waterloo in the same way that productivity did. The introduction of the Clean Air Act. Since 1972, heat rates have been essentially flat as the emphasis was shifted away to the Clean Air Act. There has been a rise in the cost of electricity which has not yet been offset by further heat rate improvements.

However, efficiencies in coal production and coal use are the tools that we have as a nation to fight the battle against inflation. Now, here's what we can do. First, the Government can help expedite removal of the inconsistencies and delays, the catch 22 situations if you will, in the current safety and environmental regulations. For example, the Mine Safety and Health Administration, MSHA certification, we have altogether up to 18 months' and even 21 months' delay in getting approval for new and improved equipment. MSHA officials are aware of this.

Let me make a suggestion. Since manufacturers are legally liable for their equipment, if it doesn't meet the law why not allow a third party certification with audit, as is done in some States on highway inspection and in most industries. For example, we're all familiar with the Underwriters' Laboratories which certifies most consumer electrical goods and industrial electrical equipment. If you did this, the manufacturers would have to pay for their own inspection and it would be done by a well-recognized, independent laboratory and might get us away from this situation.

Today, an example of the conflict: diesel carriages or trucks are approved for use in gaseous mines. Electric hydraulic drills are approved for use in gaseous mines. The two aren't allowed together. Now, the MSHA officials would like to approve them but they are caught in regulations that they haven't been able to overcome.

Of course, now, environmental laws, I would bring the point that low sulfur coal requires the same protection as high sulfur coal. To me, this is like making everybody take cold medicine because a few people have colds.

HOW GOVERNMENT CAN HELP

What can the Government help us with? There are a few new developments which are far enough out but manufacturers won't take the risk yet today. And I refer to an extension of the fluidized bed

burning process which will help improve our heat rate and will help clean up the environment. And, I think the Government might help us with pressurized fluid bed combustion.

Now, there are some consortia of businessmen working on straight fluid bed combustion, but I think we need some help on pressurized fluid bed. I might advise you that the Japanese got ahead of us in steel production by going to pressurized blast furnaces. We lagged behind them. A pressurized fluid bed combustion will do the same thing for heat rate that the pressurized blast furnaces did for the steel industry. The Department of Energy, by the way, has a line item in their budget for this but we haven't seen any money come out of it.

I would like to just tell a story about what we did right after World War II. We need cooperation today, and we got it at that time by forming what was called the National Coal Policy Conference. We had George Love from the Consolidation Coal Co.; Bill Sporn from the electric power industry; Steward Saunders from the railroads; a crusty old miner named John L. Lewis; and Bill Wearly, a young manufacturing president who got together and kicked off a program to improve the coal industry. And, Lewis, I remember, made the admonition, "My miners may lose some jobs but in return they will be the most productive and the highest paid miners in the world."

I think today, some of the results of that have paid off. We have mine-mouth powerplants, unit train haulage, trackless mining, continuous miners. All of these helped revitalize the industry.

But, times have changed. We have not only those groups that I mentioned in the role of adversaries, but we have new groups including the Government and the environmentalists. So, I think we have a great national recognition of the need for coal and we have to get together and do something about it.

I would conclude by suggesting that your committee might become familiar with and support the American Mining Congress policy for 1982 which addresses many of mining's needs. Second, you should offer your ability to highlight critical bottlenecks and help us get those bottlenecks eliminated.

The American Mining Congress has a part-time, industry-government task force working right now to achieve some of these objectives. I think you could help them by soliciting help. This is what I'm asking you to think about, from both the labor and the environmentalists.

Regulations will change much faster if consensus among the interested parties is brought to the regulators. So, possibly we can form some kind of a subcommittee with the interested parties available, and achieve something along this line.

Mr. Chairman, even though things are more difficult today to accomplish, because there are more players in the act, I still think there is great hope and I have great confidence in the future of what America can do and I think with your help we can get on and get it done.

Thank you very much.

[The prepared statement of Mr. Wearly, together with attachments, follows:]

Prepared Statement of William L. Wearly

My name is William L. Wearly. I am Chairman of the Executive Committee and Director of Ingersoll-Rand, and I appear before you today representing the American Mining Congress.

Founded in 1897, the American Mining Congress is an industry association that encompasses (1) producers of most of America's metals, coal, industrial and agricultural minerals; (2) manufacturers of mining and mineral processing machinery, equipment and supplies; and (3) engineering and consulting firms and financial institutions that serve the mining industry.

I would like to talk with you about the role of machinery and equipment in coal production and coal use.

Congressman Reuss, I am delighted that your committee has recognized the potential of coal as a substantial contributor to the economic revitalization of our country. I appreciate this opportunity to draw attention to the vital role that machinery and equipment play in coal production and coal usage.

I believe that I will be able to convince you that coal growth is highly dependent upon the availability of more productive equipment and that equipment availability is hampered considerably by roadblocks inadvertently placed by government.

Any help that your committee can be in removing these roadblocks will have a direct beneficial effect on the economic growth and the security of the United States and, through exports, of our allies.

Please be assured that our problems today do not involve limitations to manufacturing capacity.

The long lead times in the past for some coal mining and coal burning machinery and equipment do not now exist, mainly because the manufacturers have added capacity by increased capital investments.

It is currently estimated that producers of the machinery and equipment coal miners and coal users need are operating at only 60% of capacity. Perhaps in anticipation of coal growth, many of these suppliers have become part of larger and stronger companies--so they have the ability to finance expansion when needed. So manufacturing capacity is not, and will not be, a concern.

It is obvious, though, that production of mining equipment will have to increase and employ more workers--but we don't see a thing wrong with that. Matter of fact, that's why we're here today.

Let's talk now about the machinery used in the production of coal. The key word is pro-duc-tivity---How many tons of coal a man can mine in a work shift.

Productivity is important for two reasons: safety to the miner and the relative cost of labor.

In 1980, approximately 273,000 miners produced America's 824 million tons of bituminous coal. Productivity was 15.09 tons per man shift.

Increasing productivity, tons-per-man-shift, reduces the amount of time that man must be exposed to the hazards of mining to produce a ton of coal. Thus safety is improved.

Secondly, the cost of manual power, which is already much higher than mechanical power, continues to escalate, while mechanical power costs are declining relative to production.

Let us not forget that coal's current attractiveness is due in large part to its relative price stability, brought about during the last 40 years by many infusions of more productive mining methods. First from hand mining to mechanized mining in the 40's: then from track to trackless mining in the 50's: then to continuous mining mechines in the 60's: to huge open pit operations in the 70's: and now to Longwall mining.

The productivity increase in coal mining rivalled that of agriculture as one of the great American achievements. From less than 3 tons per man shift in the early 1930's, coal productivity reached 19.9 tons per man shift, the highest in the world, in 1969.

Then the introduction of the Coal Mine Health and Safety Act devasted it. Immediately the costs of coal began increasing. The next ten years saw a 47% reduction in productivity and a 380% increase in coal's selling price.

It is interesting to speculate on what coal might now cost without the use of more productive machinery. Probably coal would be far less attractive today, and we would <u>not</u> be considering it as an economic revitalization factor.

Each of these infusions of more productive machinery and equipment has helped operators keep the price of coal competitive in the face of other rapidly rising costs. And

it is this role that machinery must continue to play in the future if coal is to contribute to the economic revitalization of America.

So far, I have only mentioned machinery used in the production of coal. Equipment is equally important in the use of coal. Since 70% of coal usage is electric power generation, I will use power generation as my example.

Here the key word is "heat rate," How many BTU's (British Thermal Units) are used per kilowatt hour generated. Heat rate is the efficiency term in coal burning just as productivity is the efficienty term in coal mining.

Heat rate enjoyed continuous improvement over the past 30 years, as did productivity. By 1966, 27% less coal was required to produce a kilowatt of electricity than was in 1950.

Combustion technology and better equipment contributed to this improvement by facilitating the move to higher pressure boilers. Pressures went from 1800 lbs. per square inch to 3500. High pressure pumps, valves and boilers became available to handle the pressure.

Not only was 27% less coal required, the boiler plants and everything in them became smaller and lighter and this gave efficiencies of scale. Sizes of stations went from 60 to 500 megawatts in the same period.

Heat rate improvement met its Waterloo in the same way that productivity did-introduction of the Clean Air Act. Since 1972, heat rates have been essentially flat as the emphasis shifted,

and there has been a rise in cost of electricity which was not offset by further heat rate improvement.

Efficiencies in coal production and coal use are the tools that can be used to offset rising costs and enable stable energy costs in the future. If you will, they are ammunition in the war against inflation.

Now--How can the government help industry provide these tools? There are several ways.

First-It can expedite removal of the inconsistencies, delays, and catch 22 situations that exist in the current safety and environmental regulations and the enforcement of them.

For example, the waiting time backlog in the Mine Safety and Health Administration (MSHA) certification laboratory, before the approval process of new mining machinery can even begin, has been up to eighteen months. Then after that, the certification process has taken up to three months or a total of 21 months in some cases.

MSHA officials are aware of this delay in introducing new machinery and have asked for extra funding for personnel but every government department is being asked to cut back.

Since manufacturers are legally liable if their equipment does not meet the law anyhow, why not allow third party certification, with audit, as is done in some states now for highway truck inspection and many other industries? This would transfer the cost to manufacturers from the government and prevent the necessity of expanding a government department now critically undersized.

An example of a catch 22 situation has been the code limiting electric systems on diesel undercarriages or trucks, If you will, to lights only. This has long prevented manufacturers from mounting drills powered by electric motors on diesel-driven trucks, that are now used in gaseous situations. Even though the drills and the diesel trucks are each separately certified safe, because of a catch 22 situation in the codes they have not been useable together. The ridiculousness of this situation is recognized by all and MSHA officials requested that it be changed last year.

You might be interested to know that the change request is held up at this time in an administrative freeze on regulations. Unless we can find an effective way to bring this to the Administration's attention, this deregulation will remain stuck in the deep freeze.

An example of an inconsistency in the environmental laws is the mandating of high cost scrubbing systems to remove sulfur in power plants that burn low sulfur coal. This is analogous to requiring all Americans to take cold medicine because some Americans have colds.

Another way in which your committee could be helpful, is in calling for the expenditure of small amounts of seed money for high payout research and development. Projects that will greatly improve coal's efficiency and expedite the revitalization of the coal industry, yet that are too general to benefit any one private company sufficiently to justify private investment.

An example of this is pressurized fluid bed combustion. Fluidized bed combustion is the burning of coal in a bed of limestone. The limestone removes the sulfur and other impurities and forms fertilizer as a by-product.

Two consortiums have recently announced plans to proceed with demonstration plants.

The molten or fluidized bed combustion process resembles that of a blast furnace. Blast furnaces used to operate at atmospheric pressures.

During the last two decades blast furnaces became pressurrized and started operating at elevated temperatures and pressures. The Japanese led this process and now American steel companies find it difficult to compete with Japanese steel.

Pressurized blast furnaces are much more efficient than atmospheric furnaces, and fluidized bed combustion boilers will be too, if they are pressurized.

Think of what this can mean to America's revitalization, if we can burn high sulfur coal with no deterioration of the atmosphere, produce fertilizer as a by-product at the same time, and get more electricity from the same amount of coal.

The Department of Energy has seed money for fluidized bed combustion R & D in its budget--yet no money has been forthcoming. Your committee, by putting priority on reactivating the economy through coal, could greatly assist America for years to come by getting seed money for improving heat rate.

I was privileged to participate in coals revitalization following World War II. I know it can be done because I've

seen it done. Following the War, electric utilities needed a stable source of energy, the United Mine Workers wanted the jobs, the railroads wanted the hauling business, the manufacturers wanted to supply the machines - and the mining industry wanted to produce coal.

Life was much simpler then. George Love, from what is now Consolidation Coal Company: Phil Sporn from the electric power industry; Steward Saunders from the railroads; a crusty old miner named John L. Lewis; and a young manufacturing president named Bill Wearly, got together and formed the National Coal Policy Council here in Washington. John L. Lewis kicked it off with a $50,000 check and this admonition, "My miners may lose some jobs, but in return they will be the most productive and highest paid miners in the world."

We got mine-mouth power plants going, unit train haulage, trackless mining, and continuous miners introduced. We helped revitalized the industry and gave America years of relatively stable coal costs.

John L. Lewis realized the importance of high production labor saving machinery. When Bob Patterson, president of Australia's Coal Labor Union, refused to allow continuous miners into Australia, John Lewis called him a slave perpetuator and threw him out of his office. Today coal miners around the world drive machines and back breaking labor is out.

Times have changed. Today it is much tougher to reach a consensus of interest. Government and environmentalists have entered the picture.

But there are many things that can and should be done. If we were at war, red tape would be cut and these things would be done in the national interest. All parties would be brought together and we would work as a team against a common enemy.

Today I perceive the awakening of a national regognition of coal's potential to the country and to our allies, as a plentiful and stable energy supply. This creates a new possibility for team work. We are at war against inflation and recession. Even the intelligensia at Harvard and the liberals in the New York Times-the Socialists and many branches of government-perceive expediting the growth of coal to be in the Nation's interest. And you ask, what can we, the Joint Economics Committee do?

I suggest the following:

First--Your committee should become familiar with and support the American Mining Congress Policy for 1982 which addresses mining's many needs.

Secondly--You should offer your ability to highlight critical bottlenecks that prevent, and opportunities that lead to greater mining productivity and better heat rates.

The American Mining Congress has part-time industry government task forces working right now to achieve these objectives and you could help them by soliciting help from labor and from environmentalists.

Regulations will change much faster if consensus among the interested parties is brought to the regulators.

The vehicle for achieving consensus could be a Joint Economic Committee, sub-committee or task force composed of

representatives from MSHA environmentalists, labor and the American Mining Congress together with one of your staff members and a Reagan Administration staff member.

The cost of each representative should be born by the group that he or she represents, so that none would feel obligated. Support would be analogous to the dollar-a-year men donated to government service in times of need in the past.

In addition to being on neutral ground, and not in an adversary atmosphere, these people will devote full time to getting the regulatory consensus needed.

To avoid the building of a bureaucracy, I recommend that this function be for a limited period, and extended only if it has made a major contribution, and there is still work to be done.

Having guidance from your Committee and the American Mining Congress, this sub-committee should place the greatest priority in areas where there is agreement between all parties---environmentalists, unions, and operators---that changes in procedures, rules or laws should be made. By bringing the need, benefits, and consensus to your attention, your Committee could help expedite getting the changes made. As a founding member of the National Coal Policy Council, I've seen this approach work in the past and I'm sure it will work now.

Mr. Chairman--even things are more difficult today to accomplish, because there are more players with a voice, I still maintain great confidence in America's innate common sense and our ability to get things done.

Coal is right for America. Let's get on with it!

Thank you.

INGERSOLL-RAND

Chairman Executive Committee
Ingersoll-Rand Company
Woodcliff Lake, New Jersey 07675

BIOGRAPHICAL SKETCH:

WILLIAM L. WEARLY

William L. Wearly, Chairman of the Executive Committee and Director of Ingersoll-Rand Company, joined Ingersoll-Rand in June, 1962 as a consultant and was elected a Vice President later that year. He became a Director 1964. He was Chairman of the Board and Chief Executive Officer from 1967 through 1980.

Mr. Wearly is a graduate of Purdue University (1937) with a BSEE degree and an Honorary Doctor of Engineering (1959). He also holds an Honorary Doctor of Science from Wilkes College. He started his career with Joy Manufacturing Company's Engineering Department developing coal mining machinery and was elected Vice President in 1948, and President and Chief Executive Officer in 1957.

As a founding member of the National Coal Policy Council following WW II, Mr. Wearly helped revitalize the coal industry and the economy through the introduction of mine mouth power plants, unit train coal haulage, trackless mining machines and continuous miners.

He is a Director of American Cyanamid Company, ASARCO, ASA Limited, The Bank of New York, Sperry Corporation and UMC Industries, Inc.

Mr. Wearly is Chairman of the European Community-United States Businessmen's Council; Chairman of the British North American Committee; Chairman -- Private Sector Advisory Committee, Senate North American Trade Caucus; a member of the American Institute of Mining & Metallurgical Engineers and the Institute of Electrical & Electronics Engineers, and a Director of Boy's Clubs of America.

He is a member of The Blind Brook Club, The Round Hill Club, The Sky Club, Indian Harbor Yacht Club, Duquesne Club in Pittsburgh, and the Desert Forest Club in Arizona. Mr. Wearly and his family reside in Greenwich, Connecticut, and Carefree, Arizona. He was born December 5, 1915 in Warren, Indiana.

January 1982

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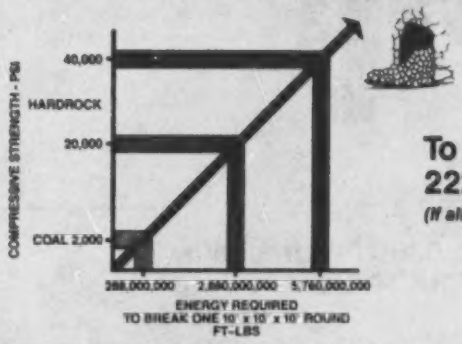
HAND MINING

(A bygone era)

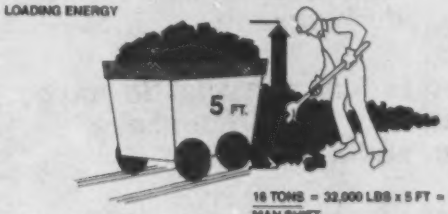
Why miners must have more productive machinery and equipment.

It's a matter of output and cost, mining enough coal and keeping it economical

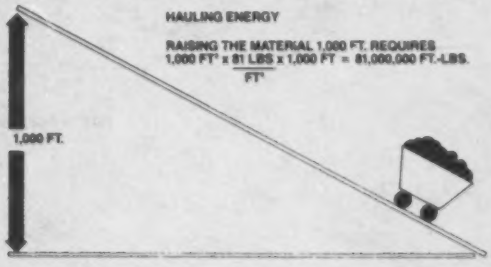
In 1982 it will take a lot of effort to mine 886,000,000 tons of coal



To break it out would take 222,000,000 kwh
(If all by shot-fired method)


LOADING ENERGY
5 FT.
1 LB x 5 FT = 5 FT.-LBS.
16 TONS / MAN SHIFT = 32,000 LBS x 5 FT = 160,000 FT.-LBS. / MAN SHIFT
1,000 FT³ x 81 LBS / FT³ x 5 FT = 405,000 FT.-LBS.

To load it would take 270,000,000 kwh
(If loaded 5 ft.)



To haul it out of the mine would take 330,000,000 kwh
(If hoisted 500 ft.)

TOTAL 579,000,000 kwh

Why miners need machinery

A miner working by hand has the following average energy output/shift.

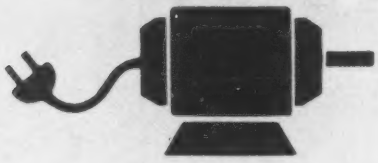
Recent Studies: **0.1 kw continuous while engaged in work.**

Folk Songs: **"Load 16 Tons and what do you get?" ...Requires 0.1 kw output over 8 hour shift.**

At today's average labor cost of $124 per shift, coal, if mined by hand would cost $1350.00 per ton.*

**Power cost only*

If mined TOTALLY with Electric Power, coal would cost 2.6¢ per ton at a 4¢ kwh Rate*

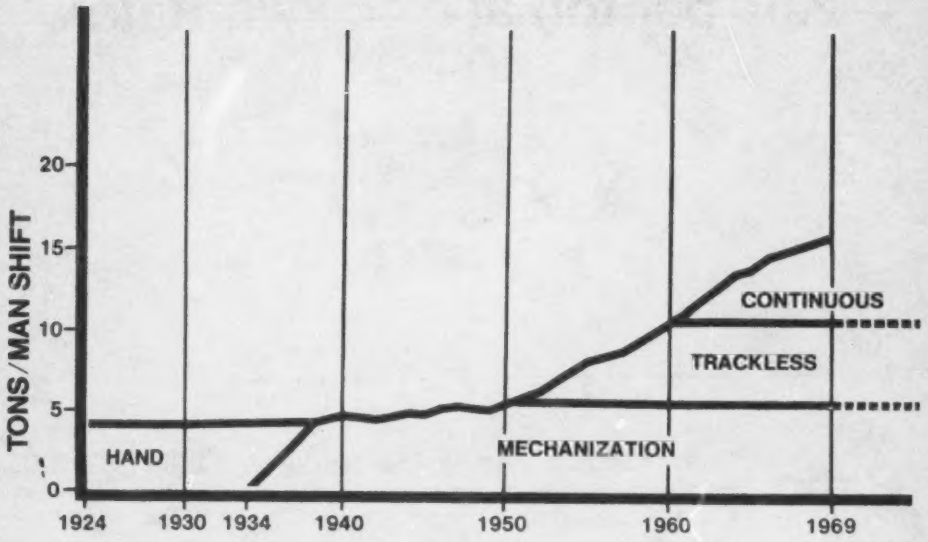


Ratio $\dfrac{\text{Cost of Manual Energy (dollars/kwh)}}{\text{Cost of Electrical Energy (dollars/kwh)}} = \dfrac{2077}{0.04} \sim \dfrac{52{,}000}{1}$

The ability to greatly expand the power of man with machinery is the underlying reason for the mechanization of mining.
As other costs keep rising, coal miners must continually replace older machinery with newer, larger and more powerful machines if coal is to remain an economical fuel.

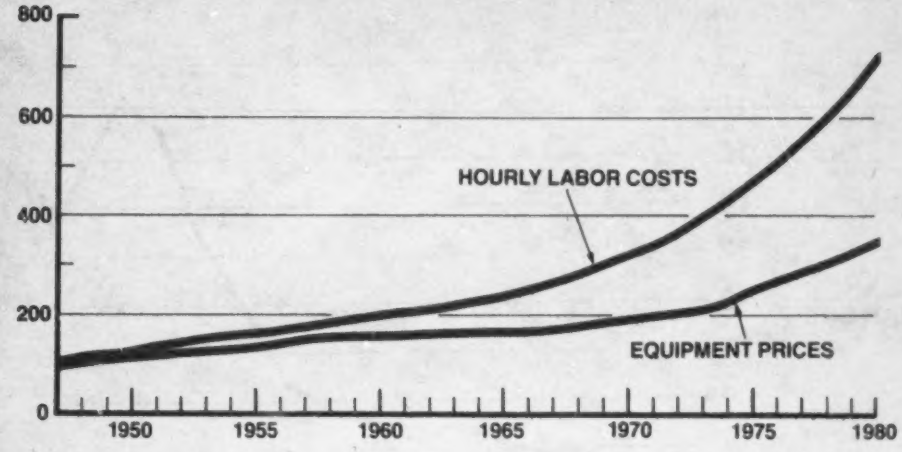
*power cost only

PREVIOUS MACHINERY ERAS THAT IMPROVED UNDERGROUND COAL MINING PRODUCTIVITY

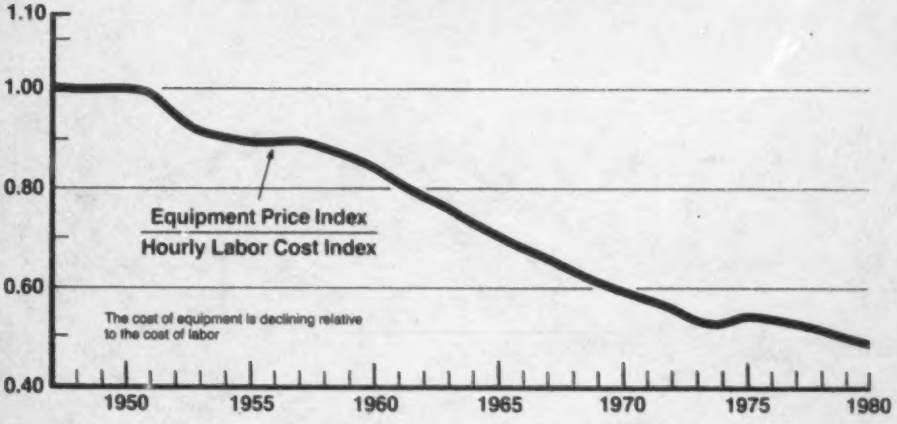


Source: Conference on Productivity and Mining, 1974.

INDEXES OF EQUIPMENT PRICES AND HOURLY LABOR COSTS

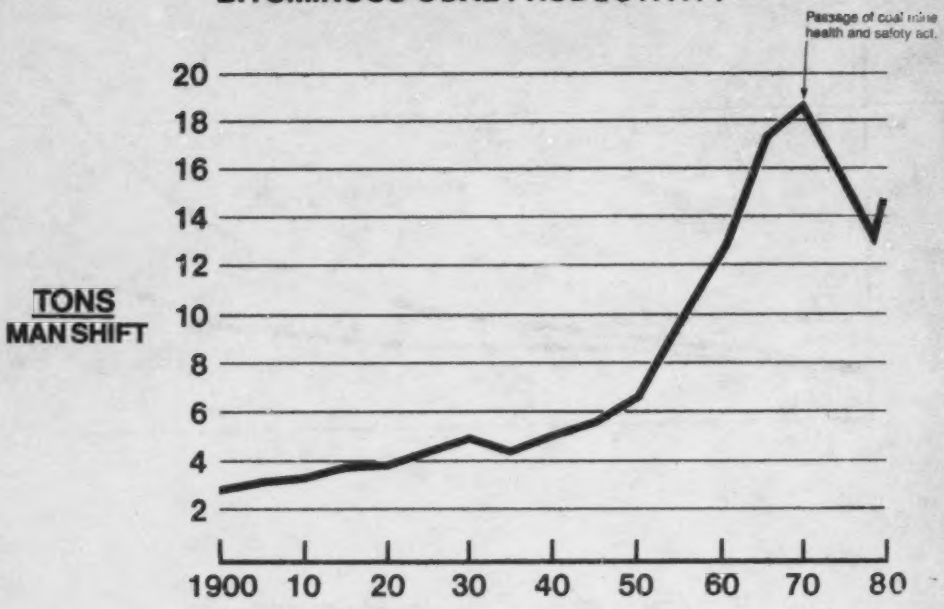


RATIO OF THE EQUIPMENT INDEX TO THE LABOR INDEX



Source: *Machinery and Allied Products Institute*

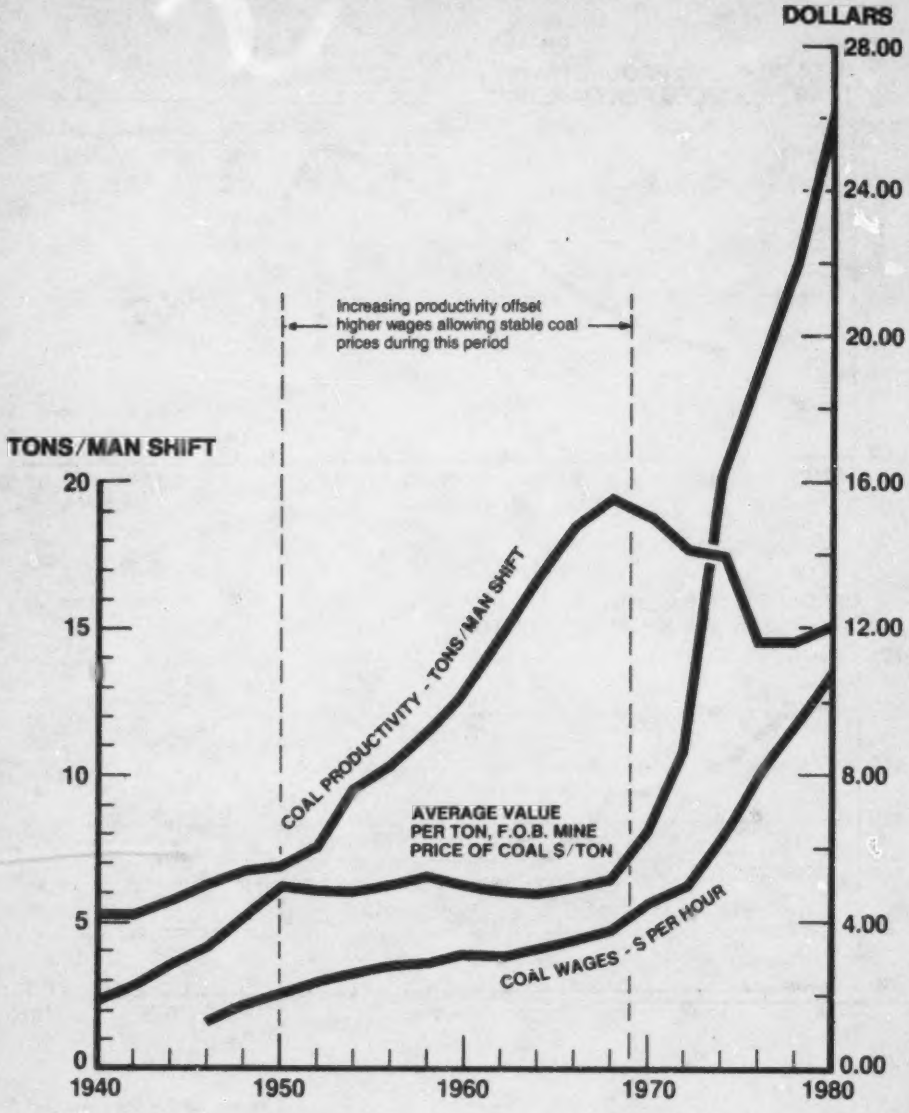
APPARENT AVERAGE UNITED STATES BITUMINOUS COAL PRODUCTIVITY*



*All types of mining

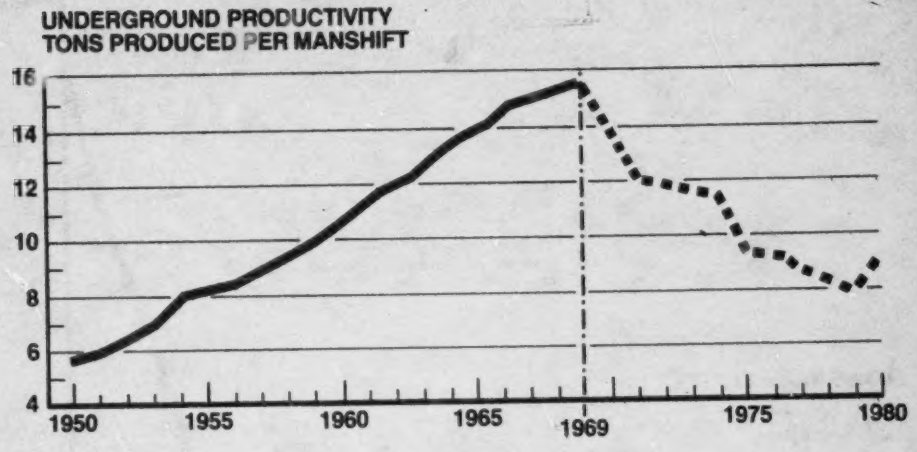
Source: National Coal Association

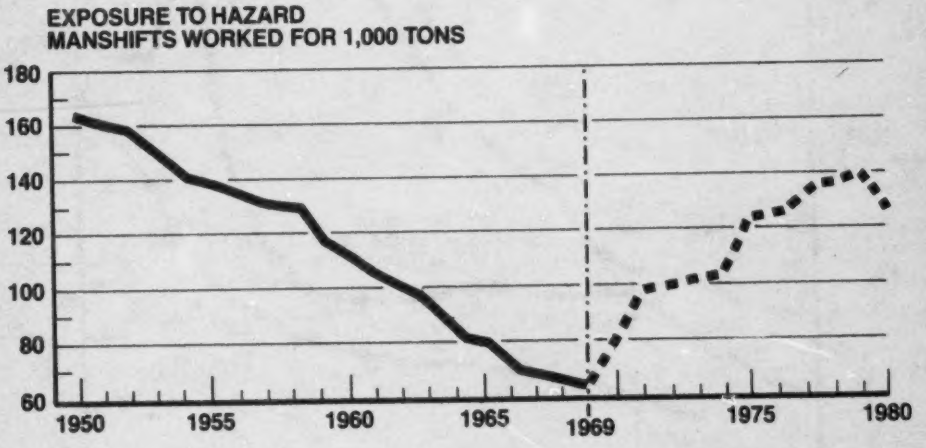
RELATIONSHIP OF PRODUCTIVITY TO PRICE



Source: National Coal Association

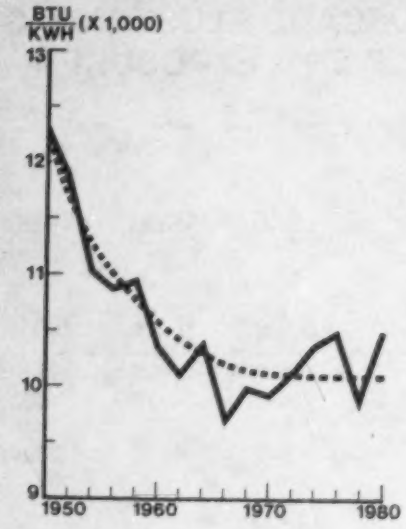
PRODUCTIVITY ENHANCES SAFETY



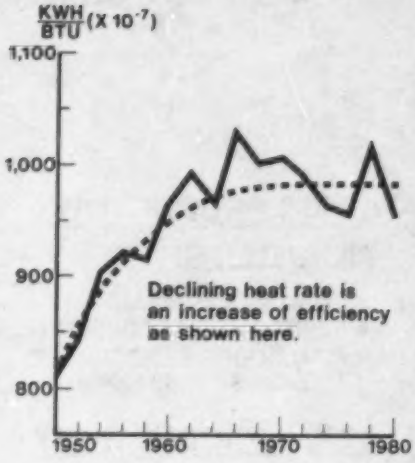


Source: National Coal Association

HEAT RATE OF STEAM STATIONS



INVERSE OF HEAT RATE (OUTPUT OVER INPUT)



Source: Electrical World Magazine, Steam Station Costs Surveys

EXTRAPOLATION OF PAST AND FUTURE PRODUCTIVITIES TO THIS DECADE ILLUSTRATING THE EFFECT ON MANPOWER & EXPOSURE

	1940	1980	1990
AT 1940'S PRODUCTIVITY			
(TON/MAN SHIFT)	**5.19[3]**	**5.19**	**5.19**
# TONS MINED (MILLIONS)	513	805	1349[2]
# MINERS REQUIRED (THOUSANDS)	533	836	1402
# MAN HOURS EXPOSURE TO HAZARDS[5] (MILLIONS)	840	1672	2804
AT 1980'S PRODUCTIVITY			
(TON/MAN SHIFT)[1]	**15.09[3]**	**15.09**	**15.09**
# TONS MINED (MILLIONS)	513	805	1349
# MINERS REQUIRED (THOUSANDS)	183	252	481
# MAN HOURS EXPOSURE TO HAZARDS[5] (MILLIONS)	288	504	962
AT 1990'S PRODUCTIVITY			
(TON/MAN SHIFT)[1]	**19.90[4]**	**19.90**	**19.90**
# TONS MINED (MILLIONS)	513	805	1349
# MINERS REQUIRED (THOUSANDS)	139	218	366
# MAN HOURS EXPOSURE TO HAZARDS[5] (MILLIONS)	214	436	732

NOTES:

(1) THIS EXERCISE ASSUMES CONSTANT MAN SHIFTS/YEAR FOR ESTIMATING PURPOSES. THIS IS OBVIOUSLY NOT THE CASE, BUT IT ALLOWS COMPARISON OF MAGNITUDES IN THE ABSENCE OF KNOWN MAN SHIFTS/YEAR IN 1980 AND 1990.

(2) NCA ESTIMATE.

(3) DOE DATA.

(4) 1969'S LEVEL. WRITER ASSUMES WE WILL GET BACK TO THAT LEVEL, OR BETTER, BY 1990.

(5) 1940'S REPORTED 1,516 MAN HOURS/YEAR; 1980 AND 1990 ESTIMATED AT 2,000 MAN HOURS/YEAR.

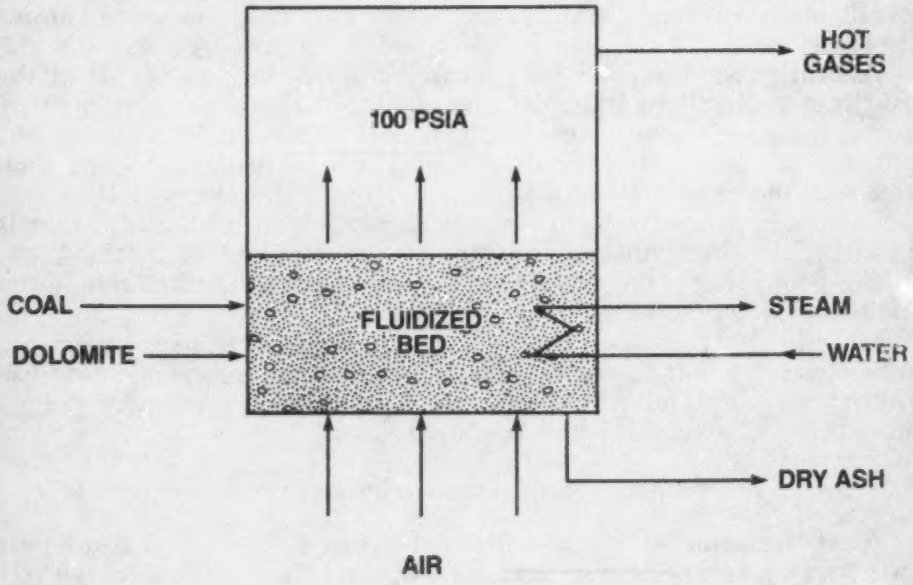
WHAT IS A PRESSURIZED FLUIDIZED BED COMBUSTOR?

- A boiler operating under pressure which burns coal in an air-blown dolomite bed yielding much higher heat transfer efficiency with one quarter the tube surface of a conventional boiler.

HOW DOES IT WORK?

- Combustion of coal occurs in an air-fluidized stream of dolomite particles at approximately 1,650 degrees F.
- Sulfur Dioxide is captured by the dolomite during combustion. NO_x formation is depressed because of low bed temperatures.
- Combustion wastes removed from combustion bed are dry and inoffensive.

SCHEMATIC



Representative REUSS. Thank you very much, Mr. Wearly.

We'll now hear from Mr. John Hertog, senior vice president of Burlington Northern.

STATEMENT OF JOHN H. HERTOG, SENIOR VICE PRESIDENT, COAL AND TACONITE, BURLINGTON NORTHERN RAILROAD CO., ST. PAUL, MINN.

Mr. HERTOG. Thank you, Mr. Chairman.

With your permission, I would like to briefly summarize the prepared statement that I have filed with you.

Representative REUSS. That will be very helpful. Your prepared statement will be included in the printed record.

Mr. HERTOG. I will touch upon perhaps the most pertinent points, so we can move on.

Certainly, on behalf of the BN Railroad whom I represent I'm very happy to be here and to speak to the issues which this committee has under consideration.

By way of information, BN is the second largest carrier of rail coal in the United States, having handled this past year about 118 million tons of coal. We serve some 41 separate utilities, who are the largest users of coal, in 19 States. And we do so with the assistance of 13 other railroads and several water carriers who serve similar destinations.

Basically, for the most part I can comment only on behalf of the Burlington Northern Railroad, and much of what I've said in my prepared statement covers our Western coal situation. In terms of the outlook, the latest DOE forecast that I've seen projects coal production will increase at about 6 percent per year after the year 1995.

Railroads currently handle about 65 percent of all the coal that is produced in the country. The heaviest growth will be in the West. We're projecting about 8 percent per year to be the growth rate in the Western areas that we serve.

I would put this one caveat in this forecast. Our past experience indicates to us that forecasts tend to be somewhat high, and recognize that energy demand will depend upon weather, Government policy, world conditions and a whole host of factors.

BENEFITS OF INCREASED PRODUCTIVITY

What are some of the benefits of increased production insofar as rail transportation is concerned? Well, the Office of Technology Assessment, in a study a few years ago, indicated that for every 100 million tons of coal there are approximately 13,000 additional transportation-related positions. From the standpoint of rail equipment, for instance, 100 million tons of coal per year would translate into equipment, in today's dollars—that is, cars and locomotives that would cost in the area of about $2.3 billion.

There has been some comment about foreign trade. In the Pacific rim market in future times it could indeed represent a very substantial opportunity for the export of coal. And if the United States could capture only a relatively small percentage of that traffic, certainly it can have a very beneficial effect upon our balance of payments.

The Far East—and we're working with several firms who represent Japanese, Taiwanese, and Korean interests, offers what we think is a

very good potential for the future. We have the benefit of the huge reserves in the West and we have the benefit in the West of a very strong rail transportation system that is already in place.

One problem that's been much discussed, the lack of port capacity, is something that I think is going to be solved. There are numerous ports in the Pacific Northwest, for instance, that have plans underway and I think the outlook is quite promising.

COAL AND THE RAILROAD INDUSTRY

Coal is very important to the railroad industry and certainly to the company that I represent. It accounts for about 50 percent of our total transportation, and in the Nation as a whole, it accounts for about 35 percent of all of the tonnage handled by railroads in 1980. It's a steady, predictable revenue base and it's very important economically to the entire transportation function carried out by the railroads.

In the past, railroads—and BN is no exception to this—had low returns compared to other industries. In part this has been due to regulatory pricing restraints and lags in allowing cost recovery. The lags have been especially significant in the past several years when we've gone through this period of rapid inflation.

The Staggers Act has tended to solve many of those problems by encouraging deregulation, indicating the railroads are to be given an opportunity to achieve revenue adequacy which is simply achieving a return equal to the cost of capital. I think it would also solve the problem of time and cost adjustments.

At the present time there's a large overcapacity in the West for coal transportation. This past year, Burlington Northern has had over 4,000 coal cars in storage and there are many cars owned by utilities that have also been in storage. We could have handled at least an additional 30 million tons of coal last year if the demand had been present.

All of our customers are receiving all of the coal they need and want and if they want more we'd be more than pleased to deliver it to them. We have in the past several years invested well over $1 billion in our plant alone for coal to achieve the present capacity. We've come from less than 20 million tons back in 1970 to the figure I gave earlier.

The proposed slurry pipeline, which is one of several on the drawing boards, only adds to that capacity. I believe, and we believe very strongly, that Congress therefore should not give Federal eminent domain to slurry pipelines for a variety of reasons, but principally recognizing that the railroads in fact are equal to the transportation demand.

There is no need for the additional capacity when a surplus already exists, and there is no justification in affording them a special privilege which, if in fact is necessary or desirable, should be obtained through the States, which is where the railroads obtained their rights of eminent domain many years ago.

Coal development, I would suggest to you, Mr. Chairman, can best be accomplished by allowing the free enterprise system as much as possible to operate free of restraint.

That summarizes my comments. I'd be happy to answer any questions.

[The prepared statement of Mr. Hertog follows:]

Prepared Statement of John H. Hertog

My name is John H. Hertog. I am senior vice president Coal and Taconite for Burlington Northern Railroad Company at St. Paul, Minnesota. I am in charge of BN's Coal and Taconite Business Unit with overall responsibility for marketing, pricing, and equipment and service planning related to the transportation of coal and taconite.

We are pleased to be invited to comment on the vital issues related to development of coal's revitalization potentials for the country's economy. Coal is extremely important to my company's railroad operations: over one-half of our freight ton miles is represented by coal traffic. We are the second largest rail carrier of coal in the U.S., and in 1981 handled approximately 118 million tons of coal, most of which originated on our lines in the Powder River Basin in Montana and Wyoming. We currently serve 41 electric utility customers located in 19 states, with assistance and cooperation from 13 other rail carriers and several water carriers.

Coal is very important to most rail carriers in the country because it provides a large, predictable traffic base and steady flows of revenue. I cannot, however, speak for the entire industry on any of the issues under consideration by this Committee, so my comments will reflect only the perspective of Burlington Northern Railroad Company and will focus mainly on Western coal, of which there are enormous reserves throughout the area west of the Mississippi.

OUTLOOK FOR COAL

Since the market areas we serve encompass only a part of the U.S., we have not attempted to forecast coal production for the country as a whole. The

latest forecast put out by the Department of Energy calls for U.S. coal production to increase at an average compounded rate of about six percent per year over the next 10 to 15 years. Production is expected to approach one billion tons in 1985; 1.4 billion tons in 1990 and 1.7 billion tons by 1995. At present, railroads transport 65 percent of coal production; at that rate our industry could be hauling well over one billion tons of coal by 1995. Those estimates look reasonable but it is important to keep in mind past projections have not been achieved and to realize that fuel demand is heavily dependent on climatic conditions, conservation practices, government policy and world conditions which are subject to future variations not entirely predictable.

Department of Energy estimates show coal production in the West rising at a faster rate than for the East. Western coal production is expected to reach 382 million tons in 1985 and will increase to 840 million tons by 1995--an increase of 120 percent over the 1985-1995 period, or 8.2 percent compounded annual rate. Eastern production over the same time span is estimated to increase 51 percent. Consequently, the economic impacts from the increased coal production and transportation are likely to be greatest in the Western states.

ECONOMIC BENEFITS

The economic ramifications of increased coal production and transportation can be sizeable. In terms of railroad employment, 100 million additional tons of coal moving in unit train operation over distances beyond 1000 miles could result in over 13 thousand additional jobs, according to employment factors developed in a 1978 study by the Office of Technology Assessment.

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These would be relatively high-paying jobs and the wages would flow into the numerous communities along the coal routes and beyond.

Increased coal transportation also translates into large orders for rolling stock--cars, locomotives and cabooses. One hundred million tons to be hauled one thousand miles in unit train service would require, using times and routes typical to BN's experience, the following equipment:

	$ millions
23,100 - 100 ton cars	1,155
1,113 - locomotives	1,113
231 - cabooses	17
	2,285

The total equipment cost in today's dollars would be $2.3 billion. That again assumes the coal moves in unit trains; single car service could require much more investment. In addition there could be hundreds of millions of dollars in investment required for track improvement, improved signalling and construction of repair facilities and added line capacity. None of this, of course, includes any of the additional investment and employment increases involved in mining the coal.

Another vital aspect of coal development is its potential to enhance foreign trade. It has been estimated that the total market for imported coal in the Far East by 1985 could be as much as 60 million tons, growing to over 200 million tons by 1995. If Western producers, railroads and ports are able to capture 25 percent of that market, it could have an important effect on our balance-of-payment situation.

Perhaps the most vital domestic aspect of increased coal production is that it translates into decreased oil and gas consumption. In this regard we must not forget that one hundred million tons of 9,000 BTU coal is the energy equivalent of over 250 million barrels of number six fuel oil. The expanded

use of coal is therefore a significant factor in reducing our dangerous dependence on foreign oil suppliers.

IMPORTANCE TO RAILROADS

As the foregoing demonstrates, expanded coal production will have a significant impact on America's railroad industry, both in challenge and in opportunity. It will ultimately be the railroads that will be called on to move most of the increased coal production, for only they have the geographically diffused system which links the coal producers with the coal users. The investment burden to accomplish this will be great; however, with the revenue flows that can be generated by coal, we should be able to mobilize the capital resources to do the job.

Beyond this, it is apparent that coal is immensely important to the viability of the railroad industry. It is the number-one commodity carried by the railroads, accounting for 35 percent of rail tonnage in 1980. Even though coal hauling rates are generally well below those of most other commodities, coal traffic provides an important revenue base for continued operations. Our industry is characterized by excess capacity and high fixed costs, and increased coal production can therefore have a strong leverage on many railroads' prospects for profitability.

REGULATION

The rail industry generally, and Burlington Northern is no exception, has not found it possible to achieve economic and financial success in recent years. Returns have been generally low as compared to the other industries; cash flows have been poor and line abandonments with accompanying service reductions have characterized much of the railroad scene. There are some exceptions to the foregoing, but overall, the industry has been less than robust.

Some of this, I believe, can be attributed to past regulatory actions that unduly restrained railroads from pricing their products more closely in accordance with basic laws of economics. Some can also be attributed to regulatory lags in making cost recovery adjustments in a timely fashion and this has been especially costly in periods of rapidly rising costs.

In October of 1980, the Congress passed the Staggers Act which sought to encourage a movement toward rail deregulation and recognized the importance of giving railroads an opportunity to achieve revenue adequacy. This term "revenue adequacy" was subsequently defined as being revenues that would make it possible to achieve returns on investment equal to the cost of capital. Also, the Act remedied the problem of lag-time where cost increases are encountered.

Since passage of the Act, however, the ICC has not, in my estimation, correctly interpreted the Staggers Act in many significant rate cases and has held some rate levels below full economic cost. In so doing, the purpose of the Staggers Act has been thwarted and our railroads economic needs have not been fulfilled.

More recently, the ICC has given somewhat closer attention to accepting cost evidence we believe more appropriately represents our rail costs and they have also endorsed the use of pricing concepts that may also be helpful. I am encouraged by these kinds of recent developments and sincerely hope it signals a true movement toward less governmental control and more reliance on using the kind of deregulated environment contemplated by the Staggers Act.

CREATION OF OVER-CAPACITY

At present in the West there is a large amount of transportation

over-capacity in terms of railroads' ability to handle coal. We had 3,500 - 4,500 empty coal cars in storage most of last year. Had the demand been present, we estimate we had the capacity to handle 30 million tons of coal out of the Powder River Basin over and above the tonnage that actually was shipped last year. This capability has come about because of a long-term program to upgrade major segments of our system and to acquire the cars and locomotives for efficient coal handling. It has involved laying heavier rail over thousands of miles of our system, construction of hundreds of miles of new tracks and sidings, wide-spread installation of automatic signalling, and construction of major repair facilities for equipment used in coal. The total cost of all these coal-related improvements and acquisitions has been over one billion dollars. Other railroads also have made sizeable investments for coal transportation.

In view of our over-capacity condition and in view of the enormous investments that have been made, we are gravely concerned about the legislation currently before Congress that would grant the privilege of Federal eminent domain to coal slurry pipeline developers. The most prominent of the slurry pipeline proposals calls for construction of a large scale pipeline parallel to our railroad from the Powder River Basin in Wyoming to Arkansas, Louisiana and the Gulf Coast. This pipeline would have a capacity of handling over 37 million tons of coal per year and latest estimates are that this duplicate system would cost up to three billion dollars to construct. In addition to BN's existing system -- which has excess capacity -- the Chicago & Northwestern, along with the Union Pacific, plan to build a rail system that would also access the Powder River Basin coal fields. What this all would add up to would be an extreme surplus of coal transportation capacity to serve this one coal producing region, and much of the investment in those systems could not be recovered

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except by increasing the charges to those customers who remained. Clearly, the overriding public benefit that is the indispensable element in granting condemnation powers to private interests is not present in the case of coal slurry pipelines, and we would hope this Congress will stay its hand and withhold the broad-eminent domain privileges that are sought.

COAL EXPORTS

I believe strongly that foreign markets hold sizeable opportunities for U.S. producers and transporters of coal as well as for the ports. In the West we are especially interested in the potentials for coal sales to Japan, Korea and Taiwan and are putting forth considerable effort to bring these potentials into reality. It is a joint effort involving coal producers, port authorities and officials of state governments, as well as the railroad industry. From the progress made to date, long-term prospects appear promising.

A number of factors bode well for Western coal exports: a large market is there, the coal is available in abundant quantities, and a high-quality rail system is in place. A major current problem is lack of port capacity. This, however, appears to be only a short-term deterrent, inasmuch as numerous port authorities and companies on the West Coast are working to develop the needed transload facilities. In the Pacific Northwest, which BN serves, many ports are prominent in coal facility development activities. I believe that the needed facilities will be developed as customer needs are specifically defined and long term committments are made.

In summary, it is the feeling of Burlington Northern Railroad Company that development of coal production, transportation and consumption can best be

carried out by encouraging the private sector to work within the free enterprise system in carrying out its individual responsibilities. As a transportation company, we have the system and the experience to perform whatever coal transportation tasks are to be required to move the resource to where it is needed. We cannot perform our function, however, if we must compete with Federally-assisted competitors or if we are not permitted to earn sufficient revenues to maintain the enterprise on a sound economic basis.

We appreciate the opportunity to offer these comments on a subject of such importance to our country's economy.

Representative REUSS. Thank you very much, Mr. Hertog.

Our last witness, Mr. Allen Dorris, president of the Coalstream Pipeline Co.

STATEMENT OF ALLEN D. DORRIS, PRESIDENT, COALSTREAM PIPELINE CO., WINTER PARK, FLA.

Mr. DORRIS. Thank you, Mr. Chairman.

The Coalstream Pipeline Co. is a wholly owned subsidiary of the Continental Group. The Continental Group is an international packaging, forest products, insurance, and energy company. This subsidiary was formed to build a major coal slurry pipeline system from the Illinois and Appalachian coalfields to serve the utilities in the rapidly growing Southeast.

In addition, the company is studying the construction of a coal slurry exporting facility at some location on the Atlantic coast. As shown on this chart here, a number of coal slurry pipelines are proposed throughout the United States. If all these pipelines were built, their length would exceed 8,000 miles. If all these pipelines are built, the result would be a pipeline system substantially more extensive than the proposed Russian gas pipeline prominent in today's news.

If these pipelines are permitted to be built, their requirements for materials and equipment would far exceed the quantity of such items now forbidden to be shipped to Russia. This recent development and its impact on U.S. manufacturers and exporters reflect another area where the benefits of coal slurry pipelines will accrue to the American people.

The purpose of my statement today is to review very briefly some of our views on the coal marketing problems of the industry and to discuss the important role that coal slurry pipelines and coal slurry export terminals can play in these markets.

The previous witnesses have discussed the market for American coal overseas and we have a set of numbers which is in our prepared statement. It isn't necessary at this time to review them, except to say that all of us seem to agree that the European market over the next 10 years will perhaps increase something in excess of 200 percent and the possibility of growth in the Pacific Rim is as much as 600 percent.

COMPONENTS OF COMPETITION

We believe that U.S. coal will be marketed both in Europe and the Pacific Rim countries only if the source of coal is reliable and the delivered cost is competitive. Our competition comes from three established coal producing nations: South Africa, Australia, and Poland and new producers such as China, Colombia, and Canada. Marks against our competitors, South Africa, Poland, and Australia are the present and potential governmental and labor instability. The mark against us is our high delivered cost of coal.

I recently visited West Germany, the Netherlands, and France. My visit there has convinced me that the overall supply security of U.S. steam coal is the major factor keeping us in this market. Coal can be delivered to any of the European markets more cheaply from South Africa and Australia and also to the Pacific Rim countries. The security of the United States as a source of coal has offset successfully our

price disadvantage of 15 to 40 cents per million Btu's in the European market and 30 to 60 cents per million Btu's in the Pacific market.

We should not rely on this security alone in the future. U.S. coal must compete in the foreign market. We all well understand this fact. However, we must not overlook the fact that the U.S. coal must also compete for the growing U.S. steam coal market. The focus of that competition is not the mine-mouth price of coal but rather the delivered price of coal, which includes the cost of transportation.

In our part of the country, Georgia and Florida, in 1980 we consumed 31 million tons of coal. It's interesting to note that 1 million tons of this coal came from South Africa and from Poland. By 1990 the coal market in Georgia and Florida is projected to more than double and should reach 84 million tons. U.S. coal will be forced to compete, not only with Poland and South Africa but for the developing coal production capacity of South America.

We have read of Exxon's planned Carre jon, Colombia, mines which will be one of the largest mines in the world and should come onstream in the mideighties.

As Mr. Carroll Wilson indicated in his testimony, and previously before the Senate Committee on Natural Resources, the Europeans and the coal importers of the Far East see a problem of the rail domination of the transportation system in this country. The concerns about the railroad pricing strategy under the Staggers Rail Act and the general dominance of the U.S. transportation by railroads were also expressed by several of the European witnesses who testified before that committee on November 10, and similarly, from Pacific Rim countries on December 1.

PIPELINES AN ALTERNATIVE

Coal pipelines can be an alternative to railroad transportation and can create competition in rail coal haulage rates. It is interesting to note, of course, that coal pipelines have been successful in this country. Consolidation Coal Co. built in the fifties a pipeline in Ohio that operated successfully for 6 years. In 1963, as a result of the threat of other proposed pipelines, the competing railroad finally agreed to negotiate unit train rates for the entire coal producing region. This reduced the coal haulage rate from $3.40 a ton to $1.88 a ton. At that time the pipeline, having achieved its purpose of forcing down coal haulage rates, was put into mothballs.

A current example of transportation by pipeline is the Black Mesa pipeline in Arizona which today transports coal for about one-half the cost to transport it by rail. My company proposes to build the most extensive coal slurry pipeline yet proposed in the United States. This is the Coalstream pipeline shown on the map to my left.

This pipeline would be designed to serve the needs of 16 power stations in Georgia and Florida which would consume 54 million tons of coal per year. In addition it would also serve a coal export terminal.

A recent study of this system by the A. T. Kearney Co. projecting rail rates that would be permissible under the Staggers Act and those permissible for the pipeline if the coal pipeline is regulated as oil pipelines are, indicates that the rates would be as shown on this chart. Over the first 20 years of operation of the pipeline, the total savings to electric generating utilities in Georgia and Florida would amount to $54 billion in inflated dollars. In 1981 dollars this would be a savings of $12 billion.

In short, we're convinced, and my company has spent several million dollars on the basis of that conviction, that interstate coal pipelines will prove to be an extremely cost effective method of transporting coal over long distances in the United States.

Turing now to export facilities, coal pipelines can also play a direct beneficial role in coal exports as well. Several U.S. companies, including my own, are actively studying the export of coal in slurry form. The drawing indicates how this system would work.

The slurry would be prepared, pumped through undersea pipelines aboard ships lying offshore in deep water, or it would be partially dewatered and this decanted water returned to shore for additional use. This would permit the use of 150,000-ton or larger ships.

The American ports presently existing generally can handle ships only in the 80,000- to 90,000-ton range. The savings, as indicated by a previous witness, are substantial in transportation by the use of these large ships.

It's interesting to note that not only are Americans interested in such facilities, but in Europe SHV is planning to build a pilot plant for the slurry offloading of coal vessels in Rotterdam. Canadian interests have recently announced they are considering the development of a coal pipeline to transmit Alberta coal to British Columbia for export. Royal Dutch Shell has studied the use of coal slurry as an inland transportation system in South Africa. Salzgitter A. G., a company wholly owned by the Federal German Republic, is intensely studying the use of a slurry system to move coking coal from West German ports to their steel mills in Salzgitter, about 100 miles south of Hamburg.

The Panamanian Government is presently studying slurry and other means of transshipping to circumvent the canal bottleneck and to facilitate the use of the next generation of large coal carriers.

Interstate coal pipelines can be built without Federal legislation that provides financial assistance, special rate structures or other such governmental assistance. Interstate coal pipelines, however, cannot be built, particularly in the Eastern United States, unless Federal legislation is enacted extending the Federal right of eminent domain to interstate pipelines. Faced with active railroad competitions, State legislatures cannot deal effectively with the issue of eminent domain for coal pipelines in their abbreviated sessions, particularly when the fundamental issues the States today face are providing essential services.

These practical problems are particularly true in those States that serve merely as hosts for the pipeline and do not benefit directly from either the production or consumption of pipeline coal. In fact, some States may encounter constitutional difficulties in identifying benefits to their citizens that would support the grant of State eminent domain.

EMINENT DOMAIN AUTHORITY

Similar difficulties led to the amendment of the Natural Gas Act in 1947 to grant Federal eminent domain to natural gas pipelines. The enactment of the Coal Act in 1941 granted Federal eminent domain authority to several interstate pipelines then proposed to be built. Federal land grants were given to the railroads in the West to

permit the construction of pipelines in the sixties. Federal eminent domain also exists for certain interstate bridge companies and to certain interstate electrical transmission companies.

Our coalstream pipeline cannot be built without this legislation, the legislation now pending before Congress in the form of S. 1844 or H.R. 4230. Of the 11 States through which our pipeline would be built, only three grant State eminent domain: Florida, Ohio, and West Virginia. The Florida statute does not become effective until all the States on our route enact eminent domain statutes. West Virginia's statutes contain several restrictions that render its usefulness very doubtful. Our pipeline must cross the lines of 11 railroad companies a total of 170 times between West Virginia, Illinois, and Florida.

Given the opposition of the railroads to our project and the impossibility of obtaining State eminent domain, we will not be able to build the pipeline without Federal eminent domain. U.S. coal will not be marketed successfully in either the U.S. market or foreign markets, unless the delivered cost of coal is competitive in the long run. This, of course, includes the price of the coal, plus the transportation. Experience indicates that coal pipelines can assist in assuring that U.S. coal is delivered at competitive prices.

The private companies mentioned stand ready and willing to build coal pipelines where the market will support them, if Federal eminent domain legislation is granted. This will provide competition to the railroads. We believe this competition will be good for the coal producers, good for the coal consumers, good for America's workers, good for our Nation's coal export trade. And it may even have beneficial aspects and effects on the Nation's railroads.

[The prepared statement of Mr. Dorris follows:]

Prepared Statement of Allen D. Dorris

Mr. Chairman and members of the Committee, my name is Allen Dorris. I am President of Coalstream Pipeline Company, a wholly-owned subsidiary of Continental Group, an international packaging, forest products, insurance, and energy company. This new subsidiary has been formed to lead the construction and operation of a proposed coal slurry pipeline that would transport coal in slurry form from the Illinois Basin and Appalachian coal fields to electric generating plants in the Southeast.

In addition, we are currently studying the construction of a coal slurry exporting facility at an as yet undetermined location on the Atlantic coast.

A number of coal slurry pipelines are proposed in the United States. Their total length would be approximately 8,000 miles. (See Figure I.) If all of these pipelines are built, the result would be a pipeline system more extensive than the proposed Russian gas pipeline system, prominent in the day's news.

If these pipelines are permitted to be built, their requirements for material and equipment would far exceed the quantity of such items now forbidden to be shipped to Russia. This recent development and its impact on U.S. manufacturers and exporters reflect another area where the construction of coal slurry pipelines may provide additional economic benefit to our country.

The purpose of my testimony before you today will be to review the market for U.S. steam coal and to discuss the important role coal pipelines and coal slurry export terminals, such as those proposed by Coalstream Pipeline, can play -- both in preserving the market for U.S. steam coal and in assisting our domestic coal to be competitive in foreign markets. I appreciate the opportunity to appear before you today.

I. THE COAL MARKET IN WHICH U.S. COAL MUST COMPETE:

A. The European and Pacific Rim Markets:

U.S. steam coal must compete against foreign coal in at least three distinct markets: the European market, the Pacific Rim market and the U.S. market. The projected foreign market for U.S. steam coal is huge. (See Table 1.) For example:

- Belgium-Luxembourg, Denmark, France, Italy, The Netherlands and West Germany used 46.1 million tons of steam coal in 1979, but are projected to use 122.2 million tons in the year 1990 -- an increase of almost 265% in 10 years.

TABLE 1

World Steam Coal Demand
By Selected Country
1979 - 2000
(millions of short tons)

	1979	1990	2000	Average Annual Growth Rate 1979-2000
Europe (six largest)				
Belgium-Luxembourg	5.8	17.3	30.5	8
Denmark	7.6	16.1	21.9	5
France	21.0	19.0	30.5	2
Italy	2.1	39.1	50.0	16
Netherlands	2.6	15.1	35.2	13
West Germany	7.0	15.6	39.2	9
Pacific (three largest)				
Japan	2.7	48.3	108.7	18
Korea	5.9	16.1	50.6	11
Taiwan	5.3	16.1	41.4	10

Source: Midrange estimates of Interagency Coal Export Task Force study, p. 42.

- Japan, Korea and Taiwan used 13.9 million tons of steam coal in 1979, but are projected to use 80.5 million tons of coal in 1990 -- an increase of almost 600% in the same 10-year period.

We believe that U.S. coal will be marketed successfully in both the European and Pacific Rim markets only if the source of the U.S. coal is reliable and the delivered cost is competitive. Our competition comes from three established coal producing nations, South Africa, Australia and Poland, and new producers such as China, Colombia and Canada. (See Table 2). The marks against our major competitors, South Africa, Poland and Australia, are present and potential governmental and labor instability. The mark against us is our higher delivered cost of coal.

My recent visits in West Germany, The Netherlands and France have convinced me that, to date, the overall supply security of U.S. steam coal is the major factor keeping the U.S. in the European steam coal market. In 1980, the delivered cost of steam coal to Europe from South Africa was $1.95/million Btu's; from Australia was $2.20/million Btu's and from the U.S. was $2.35/million Btu's. Similarly, during 1980, the delivered cost of steam coal to the Pacific Rim markets from Australia was $1.60/million Btu's; from South Africa was $1.95/million Btu's; and from the U.S. and Canada was $2.25/million Btu's. (See Table 3.)

Thus, for the present, the security of the U.S. as a source of coal has offset successfully our price disadvantages of 15 to 40 cents per million Btu's in the European market and 30 to 60 cents per million Btu's in the Pacific market. We cannot rely on this "security" premium alone in the future.

B. The U.S. Market:

That U.S. coal must compete for the foreign market is well understood. However, we must not overlook the fact that U.S. coal must also compete for the growing U.S. steam coal market as well. The focus of that competition is not the mine-mouth price of coal, but rather the delivered price of coal, which includes the cost of transporting coal to its point of use.

In 1980, over 31 million tons of coal were used in the states of Georgia and Florida. Included in this figure are almost one million tons of coal imported from foreign sources: 750,000 tons of steam coal were imported from South Africa by Gulf Power Company and 240,000 tons of coal were imported from Poland by Tampa Electric Company.

TABLE 2

World Steam Coal Supply
(millions of short tons)

Country	1979	1990	2000
U.S.	14.1	64	197
South Africa	n/a	65	90
Australia	n/a	37	97
Poland	n/a	55	55
Colombia	n/a	17	30
China	n/a	10	30
Canada	n/a	7	14
U.S.S.R.	n/a	3	7
TOTAL	77	258	520
U.S. Share (%)	18	25	38

Source: Midrange estimates of Interagency Coal Export Task Force study, projections, pp. 6-18.

TABLE 3

Comparative Delivered Cost of Coal
(1980 $/MMBtu)

European Market

Source	Mine-Mouth Cost	Transportation Costs		Total Cost
		Inland	Ocean	
U.S.	1.65	.35	.35	2.35
Australia	1.00	.15	1.05	2.20
South Africa	1.00	.30	.65	1.95

Pacific Rim Market

Source	Mine-Mouth Cost	Transportation Costs		Total Cost
		Inland	Ocean	
U.S.	1.10	.70	.45	2.25
Australia	1.00	.15	.45	1.60
South Africa	1.00	.30	.65	1.95
Canada	1.35	.50	.40	2.25

Source: Interagency Coal Export Task Force study, p. 99

By 1990, the coal market of Georgia and Florida is projected to more than double to 84 million tons of steam coal. U.S. steam coal will be forced to compete for this expanded market with not only Poland and South Africa but the developing coal production capacity of South America. For example, Exxon is developing one of the world's largest mines at Cerrejon, Colombia which reportedly will be in production by the mid 1980's. Utilities in Florida and Georgia are under an affirmative obligation to purchase the least expensive coal available to them. Thus, our country's eastern coal may simply lose much of the growing Florida and Georgia market to foreign coal unless the delivered cost of U.S. coal can compete with imported coal.

II. THE ROLE OF COAL PIPELINES:

On September 19, 1980, Dr. Carrol L. Wilson, Director of the World Coal Study, testified before the Energy and Minerals Resources Subcommittee of the Senate Committee on Energy and Natural Resources in a hearing on coal exports. In reporting on the concerns about the U.S. expressed by steam coal importers in Europe and the Far East, Dr. Wilson reviewed some of the fears that had been expressed to him, stating:

> "They also see a rail domination which would exclude supply by alternative systems such as slurry pipelines." (p. 262 of the transcript)

Concerns about railroad pricing strategies under the Staggers Rail Act and the general dominance of U.S. coal transportation by the railroads were expressed by several of the European witnesses who testified before the same Subcommittee on November 10th, including particularly the witnesses from Belgium, France, Finland and Italy. Similar concerns were expressed on December 1st by witnesses from the Pacific Rim countries.

A. Inland Coal Transportation:

Coal pipeline systems can be an alternative to railroad transportation and can create competition in rail coal haulage rates. To date, coal pipelines have proven to be cost effective and reliable modes of transporting domestic coal in two basically intrastate systems in Ohio and Arizona. Unable to negotiate for lower unit train rates for its coal shipments, Consolidation Coal Company built and operated an intrastate coal pipeline in Ohio. For six successful years, the pipeline transported coal at rates consistently lower than existing competing rail rates. In 1963, as a result of the success of this coal slurry pipeline and the threat

of other proposed pipelines, the competing railroad finally agreed to negotiate unit train rates for the complete region. The rail coal haulage rate dropped from $3.47/ton to $1.88/ton. At this time, the pipeline, having achieved its purpose, was put in reserve. A current example of transportation cost savings is the Black Mesa Pipeline in Arizona which today transports coal for about one-half the cost to transport it by rail.

My company proposes to build an interstate coal pipeline, which we call the Coalstream Pipeline, to deliver up to 54 million tons of coal per year 1500 miles from the Illinois Basin and the Appalachian coal fields to Florida and Georgia. (See Figure II.) A recent study of our Coalstream project by A. T. Kearney, Inc. (May, 1981) concluded that transporting that amount of coal by pipeline rather than rail would result in an aggregate transportation savings of $12 billion in 1981 dollars ($54 billion in as-spent dollars) for the twenty year period beginning in 1988. (See Figure III.)

In short, we are convinced, and my company has spent several million dollars on the basis of that conviction, that interstate coal pipelines will prove to be an extremely cost effective method of transporting coal over long distances in the United States.

B. Coal Export Facilities:

Coal pipelines can play a direct beneficial role in coal exports as well. Several U.S. companies, including my own, are actively considering the development of coal slurry export facilities in which coal is moved by undersea pipeline from onshore staging areas to large colliers. (See Figure IV.) Water is decanted on board ship and returned to shore for reuse. Coal can be delivered to such slurry export facilities either by coal pipeline, railroad, truck or barge.

Such projects will help keep American coal competitive by enabling coal to be moved through uncongested ports by large ships, those in classes of 150,000 deadweight tons or larger. The per ton cost of using larger ships for coal haulage is much less than the cost for smaller ships, as Table 4 indicates. Larger vessels are expected to dominate our coal export trade beginning in the 1990's. Large ships, however, have a deep draft which cannot be accommodated in U.S. ports that, until extensive dredging is done, generally can accommodate no larger than fully loaded 80,000-90,000 ton ships. Although some technical details remain to be decided on the design of slurry loading coal, a number of other mineral slurry shiploading facilities exist and are functioning well.

C. Foreign Interest In Developing Coal Pipelines:

Interest in applying pipeline technology to coal transportation is by no means limited to the U.S. SHV in Rotterdam is planning to build a pilot plant for the slurry off-loading of coal vessels in Rotterdam. Canadian interests recently have announced that they are considering the development of a coal pipeline to transport Alberta coal to British Columbia for export. Royal Dutch Shell has studied the use of coal slurry as an inland transportation system in South Africa. Salzgitter, A. G., a company wholly-owned by the German Federal Republic, is intensively studying the use of slurry systems to move coking coal from West German ports to their steel mills in Salzgitter, about 100 miles south of Hamburg. The Panamanian government is studying slurry and other means of transshipping coal to circumvent the canal bottleneck and to facilitate the use of the next generation of large coal carriers that are expected to become dominant in the late 1980's. (See Table 4.)

III. NEED FOR FEDERAL EMINENT DOMAIN LEGISLATION

Interstate coal pipelines can be built without federal legislation that provides financial assistance, special rate structures or other such governmental assistance. Interstate coal pipelines cannot, however, be built, particularly in the eastern United States, unless federal legislation is enacted extending the federal right of eminent domain to interstate coal pipelines.

Faced with active railroad opposition, state legislatures cannot deal effectively with the issue of eminent domain for coal pipelines in their usual abbreviated sessions, particularly when the fundamental issues of providing essential state services are today so difficult and time consuming. These practical problems are particularly true in those states that serve merely as hosts and do not benefit directly from either the production or consumption of pipeline coal. In fact, such states may encounter legal difficulties in identifying benefits to their citizens that would support the grant of state eminent domain authority to such coal pipelines.

Similar difficulties led to the amendment of the Natural Gas Act in 1947 to grant federal eminent domain authority to interstate natural gas pipelines; the enactment of the Cole Act in 1941 to grant federal eminent domain authority to several interstate petroleum pipelines; the grant of federal eminent domain authority to the land grant railroads (Santa Fe, Union Pacific and Burlington Northern); the grant of federal eminent domain authority to interstate bridge companies and to certain interstate electric transmission projects.

TABLE 4

Average Daily Cost of Vessels
(Dollars Per Ton)

	Ship Size (DWT)		
	60,000	100,000	150,000
Daily Cost Per Ton*($)	.527	.405	.318

*Includes capital cost, fuel cost, vessel expenses

Source: Interagency Coal Export Task Force study, p. 88

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Coal Export Ship Size
(Percent of Total Fleet)

Ship Size	1980	1985	1990	1995	2000
Less than 100,000 DWT	93	75	56	48	42
Greater than 100,000 DWT	7	25	44	52	58

Source: Interagency Coal Export Task Force study, p. 89

Our Coalstream Pipeline simply cannot be built without legislation, such as S. 1844 or H.R. 4230, that has been co-sponsored by two members of this Committee and is now pending before this Congress. Of the eleven states through which our pipeline could be built, only three grant eminent domain authority to coal pipelines -- Florida, Ohio and West Virginia. Florida's statute does not become effective until all states along our route enact eminent domain statutes for coal pipelines. West Virginia's statute contains several restrictions that render its usefulness very doubtful.

Our pipeline must cross the lines of eleven railroad companies a total of 170 times from West Virginia and Illinois to Florida. Given the opposition of the railroads to our project and the impossibility of obtaining state eminent domain authority, we will not be able to build our pipeline without the right of federal eminent domain.

IV. CONCLUSION:

Mr. Chairman, U.S. coal will not be marketed successfully in either the U.S. market or foreign market unless the delivered cost of our coal is competitive. The delivered cost of coal includes both the mine-mouth price of the coal and the cost of transportation. Experience indicates that coal pipelines can assist in assuring that U.S. coal is delivered at competitive prices. Private companies stand ready and willing to build coal pipelines where the market will support them. Federal legislation will allow these interstate projects to compete in our inland coal transportation market. The competition will be good for the coal producers, good for coal consumers, good for America's workers, good for our nation's coal export trade -- and may even have beneficial effects on the nation's railroads.

Thank you very much.

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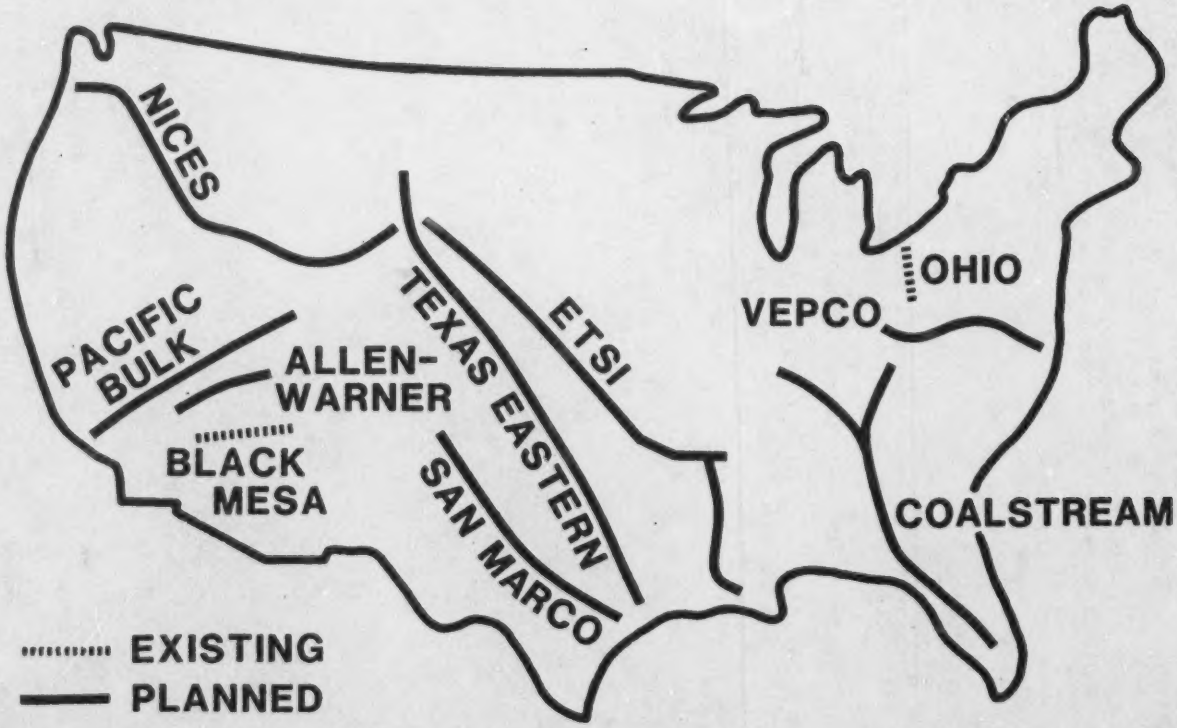
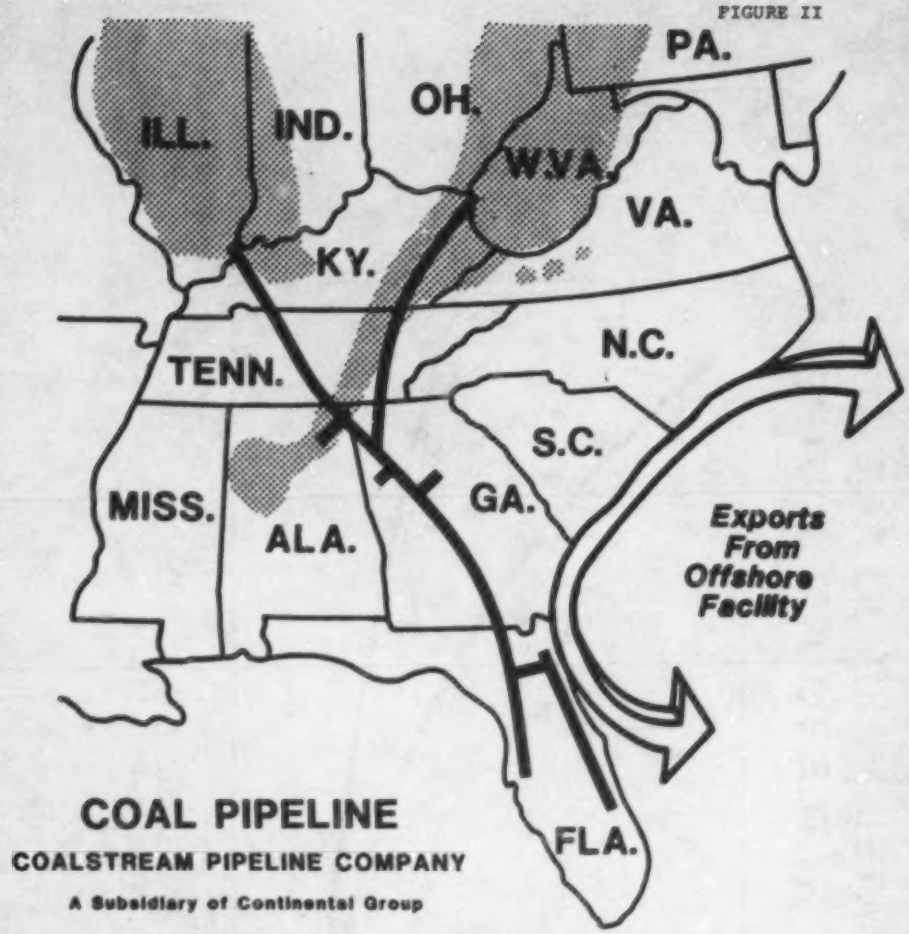
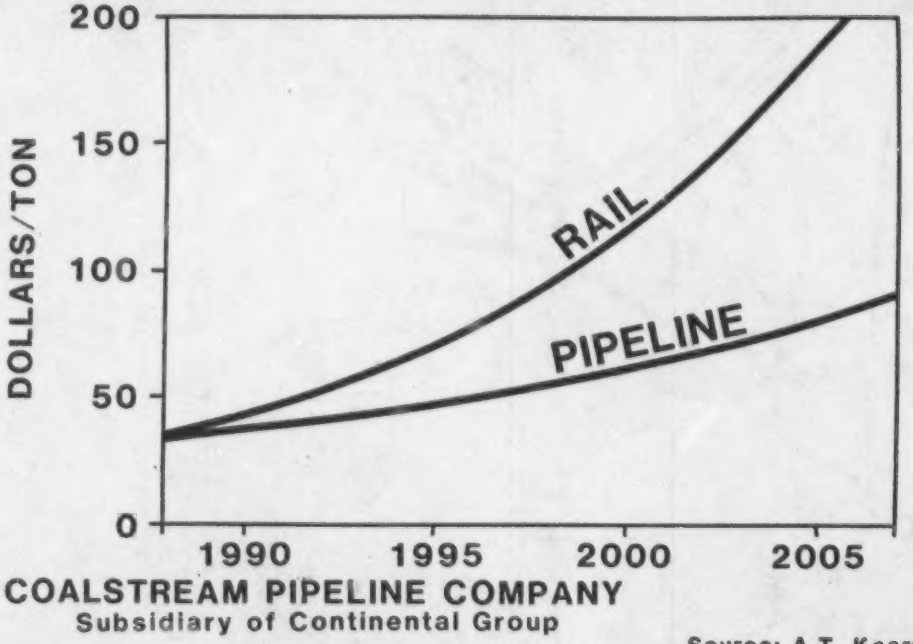

U.S. COAL SLURRY PIPELINE SYSTEMS
NICES
PACIFIC BULK
ALLEN-WARNER
BLACK MESA
TEXAS EASTERN
SAN MARCO
ETSI
OHIO
VEPCO
COALSTREAM
EXISTING
PLANNED

FIGURE I

PIGURE II


PA.
ILL.
IND.
OH.
W.VA.
VA.
KY.
N.C.
TENN.
S.C.
MISS.
ALA.
GA.
Exports From Offshore Facility
FLA.
COAL PIPELINE
COALSTREAM PIPELINE COMPANY
A Subsidiary of Continental Group
COAL PRODUCING AREAS
UNDERGROUND PIPELINE SYSTEM

ESTIMATED MAXIMUM RAIL AND PIPELINE RATES TO THE SOUTHEAST



Source: A.T. Kearney

FIGURE III

FIGURE IV

SINGLE POINT MOORING
FLOATING HOSES
SPM
SLURRY LINE
RETURN WATER LINE

Representative REUSS. Thank you, Mr. Dorris. Thanks to all the members of the panel. I guess having Mr. Dorris before us, we'll start right out.

KEEPING DIRTY WATER OUT OF SEA

Can I have the picture illustrating your offshore loading? If Congress goes ahead and authorizes eminent domain for coal slurry pipelines, what assurance would there be in connection with, let's say, with your coal export proposal that instead of taking the dirty water which is transporting the coal back to land and lagooning it or whatever you're going to do with it. What assurances would there be that you're not just going to dump it in the sea?

Mr. DORRIS. Well, as you of course, know, no water can be discharged into waterways without Federal permits and in many cases State permits. Water to be discharged must have a permit. So simply the law would not permit the discharge of the dirty water.

Representative REUSS. How far out from land does that permit requirement go?

Mr. DORRIS. There are laws, of course, of the sea, which are international in scope. I believe that the Federal jurisdiction—I think this varies in different parts of the coast—extends 12 miles to sea. In some places the States' rights only go out about 3 miles. I understand.

Representative REUSS. Apart from the dumping in the sea problem, what does the coal slurry pipe industry propose to do with the soiled water?

Mr. DORRIS. The amount of water used in making the slurry to supply a particular powerplant represents about 15 percent of the requirements of the water for a powerplant. In other words, if we were delivering coal to a powerplant by pipeline, 15 percent of the requirements of water for that powerplant would be supplied in that fashion.

Representative REUSS. Can the powerplant use without corrosion the, I presume, quite dirty water?

Mr. DORRIS. Surprisingly, it is not quite dirty. Coal slurry, if allowed to stand in a beaker, for example, will settle and the water will be perfectly clear on top. It's only fair to say that there are certain chemicals dissolved in that clear water, and these vary, depending on the particular type of coal that is involved. There are existing technologies for treating the water to whatever degree of cleanliness is required. If it's to be used in a powerplant, it would be principally used for wash water or such things as transporting ashes or washing the plant down. Or it would be used as makeup water in the cooling towers of the powerplant where it would be evaporated.

ADMINISTRATION'S POSITION ON PIPELINE

Representative REUSS. Secretary Mares, what is the administration's position on the important economic issue debated between Mr. Hertog from Burlington and Mr. Dorris of Coalstream? The administration generally proclaims its adherence to the idea of competition. What is its position on the proposal to give eminent domain powers to coal slurry pipelines?

Mr. MARES. The administration's position has been not to support that proposal on the grounds that it is a judgment to be made by the States. There has been at least one long distance coal slurry pipeline that has obtained the permits. Thus, the judgment of the administration is that it is not necessary for there to be a Federal eminent domain statute for the purposes of a coal slurry pipeline.

STATE ROLE IN EMINENT DOMAIN

Representative REUSS. What do you say to the testimony of Mr. Dorris. He puts it quite tactfully, and I quote, "Faced with active railroad opposition, State legislatures cannot deal effectively with the issue of eminent domain for coal pipelines in their usual abbreviated sessions. That conjures up pictures of smoke-filled rooms that make the brain reel, but what about that? Apparently only three States—Florida, Ohio, and West Virginia—have passed eminent domain legislation. And according to Mr. Dorris two of those are ineffective.

Mr. MARES. I think the position of the administration is fairly clear on this. We believe it is something that is appropriate for the States to resolve. It has been resolved with respect to the ETSI line that was referred to. It's inappropriate for us, the administration, the Federal Government, to impose a new regulation upon the States.

Representative REUSS. Well, why is that? Why is it inappropriate? The Federal Government just last weekend got through with some social engineering regarding A.T. & T. and IBM, designed to secure more competition. Why do you say leave it to the States in this field of slurry pipelines, particularly in view of the failure of the Eastern States, at least, to do anything to enhance competition by permitting eminent domain for slurry pipelines.

Mr. MARES. I think you're making a judgment that there has been a permanent failure. I think there is certainly an argument which says that the Federal Government is not going to step in and try to "solve the problem," for the reasons that I've stated. That's not to say that the firms, including those at this table and the individual legislatures, seeing what the economics are, wouldn't decide to address the problem themselves.

Representative REUSS. Well, is the mind of the administration closed for all time on this, or if there were a demonstration that the States, or at least certain States, were not moving to permit slurry pipelines eminent domain, would that produce a change in attitude?

Mr. MARES. I think as of this moment, the position is fairly clear. I think there are circumstances in regard to any matter of national policy or domestic policy which can change, which can cause decisions to change. But as of this moment, I would be presumptuous to offer any hope that the policy would be changed.

Representative REUSS. The Federal Government, all the time, and quite properly, interests itself in what State governments are doing. That's what federalism is all about. Does the administration think it would be a good idea if State governments passed legislation permitting eminent domain to slurry pipelines?

Mr. MARES. The administration is quite clearly in support of competition and the marketplace and in support of the export of coal. This is a possible way that coal exports could be supported. The President has requested the Secretaries of Energy and the Interior to work with the States to secure rights-of-way, but it has not been a policy of do nothing. It's clear that we have been encouraged to work with the States regarding this issue.

Representative REUSS. Work with the States, how? To do what the railroads say and not allow slurry pipelines or to encourage the States to pass legislation allowing slurry pipelines?

Mr. MARES. I think the issue is to allow the marketplace to work with the least number of regulations being imposed by the Federal

Government we can and to encourage the consideration of economic cost-effective forms of transportation.

Representative REUSS. That means then that the administration encourages States without any subsidy to slurry pipeline companies to permit them to have the same eminent domain rights that other pipelines, such as oil and gas, for example, have had. Is that the position?

Mr. MARES. It would certainly be fair to provide information as to the economics of it in the manner we best understand it, but it's ultimately a State decision.

Representative REUSS. Well, how do you understand the economics? From what I've heard today, it does seem to me as if the more competition the better. As long as the pipeline companies don't ask for any subsidy from anybody, why shouldn't we let them take their chances? If they go broke, that's their hard luck.

Mr. MARES. You have described an argument which if presented to a national legislator like yourself, r a State legislator, that I'm sure you'd come to a decision that you would approve of.

CLEAR ADMINISTRATION POSITION NEEDED

Representative REUSS. Well, I won't pursue the fencing here, but I will say that the administration should have a clear position. Either we want to get coal to market for domestic or export use as cheaply as possible, or we don't. And it does seem to me, the more competing methods, railroads, large lines, trucks, and all the other methods known to man, the better. Does that bother you?

Mr. MARES. No.

Representative REUSS. Let me turn to Mr. Train now and thank him for his most instructive statement. Would it be a fair summary, Mr. Train, of your statement that you stick by your guns as a member of the coal study group which said, "Yes, let's go ahead with coal. Let's work for its trebling in the next 18 or 20 years"? But you go on to say that you think the public is entitled to firmer safeguards against environmental deterioration than are now in place. The fact is, I believe you indicated that acid rain is not now necessarily being eliminated and other forms of air pollution are not now necessarily being eliminated; that the CO_2 problem is not being adequately addressed; and that it is your view that whether or not this Nation emmarks upon a major program of encouraging coal, which I tentatively, at least, think we should do. we need more vigorous methods of preventing the detrimental effects of burning coal from wreaking damage. Is that your position, in short?

COAL DEVELOPMENT AND THE ENVIRONMENT

Mr. TRAIN. I think generally that is a fair summary of what I have to say. I don't believe I expressed any view that the present effort with respect to the CO_2 effect, in terms of research is inadequate. I simply don't know. I believe that the administration has been supporting a quite substantial research effort in this area, and I do not intend to be critical of that effort. It mav be adequate, although I am sure one could always step it up. I also didn't intend to make a judgment as to what present levels of standards are. What I did mean to say is that in my view the premises of the report and my support of those premises in terms of environmental aspects, are based upon an assumption that high standards will be maintained. And I expressed concern over what I see as indicators today, flags of warning, if you

will, that we may be moving away from such standards. And if that should turn out to be the case, then I would say that the premises of the report in terms of environmental health and safety impacts would no longer be valid in my view.

WHO MONITORS CO_2 PROBLEM?

Representative REUSS. On the CO_2 greenhouse effect problem, you said just now that the administration does have underway a serious research program.

What can be said about measurement? I have the impression that—I'm not sure that we have really set up a monitor on this. Is it the Department of Energy? Is it the EPA? Is it the Department of Commerce? Is it NOAA? I am not sure that whoever it is who is supposed to warn us about undue concentrations of CO_2 has been told that that's what they're supposed to do. Am I overlooking something, or is there a possible gap in our armor there that ought to be chinked?

Mr. TRAIN. Well, I think you would want to have the testimony of the Administrator of NOAA, John Byrne, on this point. NOAA is, to my understanding, the lead agency on such monitoring, not EPA and not the Department of Energy. I am looking at Mr. Mares for confirmation of this.

Mr. MARES. They are involved. I believe the Department of Energy and the Office of Energy Research within the Department is the lead agency on this, both on the national committee, and the Interagency Committee on CO_2 and the Climate.

But I might provide at least some factual background, as I understand it. There is underway an analysis of atmospheric CO_2 data which has been collected from about 15 stations over the past decade. I don't know whether those 15 have been worldwide, or their exact locations, but there has been data collected other than at the site mentioned in Hawaii.

Representative REUSS. I think it would be appropriate to ask you, if its not an imposition, Mr. Mares, for you to prepare and file for the record, and have it included at this point in the testimony, a go around on just who is doing the monitoring.

The purpose of the question is not to affix blame for anybody. For all I know, it is being adequately done. But on a matter as important as this, we want to be very sure it's adequately done, and if there is a blur or a gap in what we ought to be doing by way of monitoring, let's note it now, because it isn't by any means the most difficult thing in the world to prepare it.

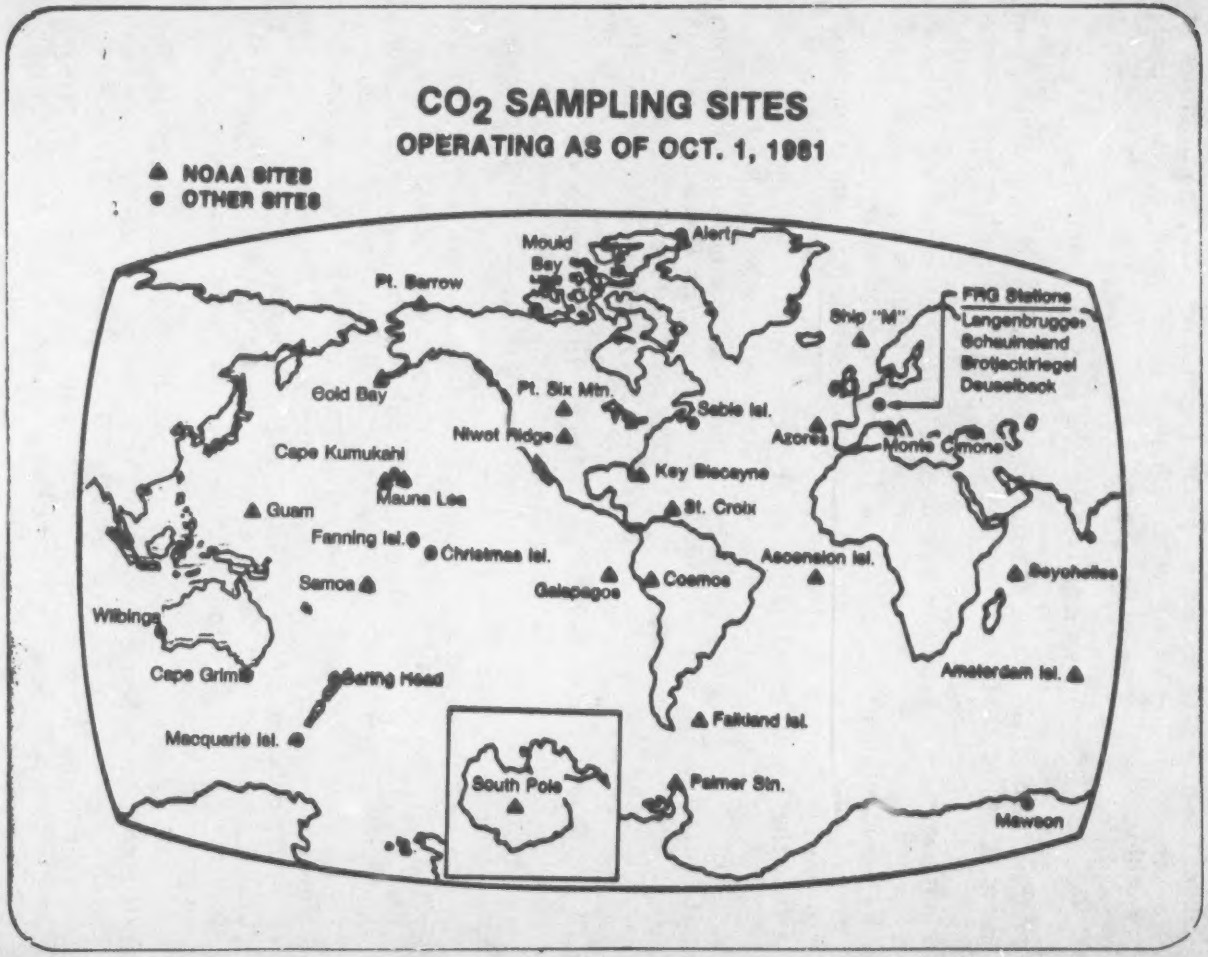
Mr. MARES. We would be pleased to do so.

Representative REUSS. Thank you.

[The following information was subsequently supplied for the record:]

CARBON DIOXIDE MONITORING NETWORK

The National Oceanic and Atmospheric Administration, working with the World Meteorological Organization, has extensive flask network where samples of atmosphere are taken and analyzed continuously for atmospheric carbon dioxide concentrations. The attached map shows the worldwide locations of this carbon dioxide monitoring network. The Department of Energy funds and coordinates the world standards activities for this measuring activity through the Scripps Institute of California. The National Bureau of Standards is also being funded by the Department of Energy to develop international standards for all levels of carbon dioxide concentrations as measured as the worldwide locations.


CO_2 SAMPLING SITES
OPERATING AS OF OCT. 1, 1981
▲ NOAA SITES
● OTHER SITES
Mould Bay
Alert
Pt. Barrow
FRG Stations
Langenbrugge
Scheuinsland
Brotjacktriegel
Deuselbach
Ship "M"
Gold Bay
Pt. Six Mtn.
Sable Isl.
Niwot Ridge
Azores
Monte Cimone
Cape Kumukahi
Key Biscayne
Mauna Lea
St. Croix
Guam
Fanning Isl.
Christmas Isl.
Ascension Isl.
Seychelles
Samoa
Galapagos
Cosmos
Wilbings
Cape Grim
Barring Head
Amsterdam Isl.
Falkland Isl.
Macquarie Isl.
South Pole
Palmer Stn.
Mawson

TECHNOLOGY AND ACID RAIN

Representative REUSS. On acid rain. Mr. Train, the technology for dealing a massive blow to acid rain is, as I understand it, at hand: The use of low sulfur coal, washing coal, scrubbers, at a utility plant, and perhaps the most exciting of all, fluidized bed generation. Those things, as I understand it, do offer the potential of really lowering sulfur oxide and nitrogen oxide emissions, which are apparently the great causes of dead lakes and other problems of that stripe. Is that your impression?

Mr. TRAIN. That is correct. I think the thrust of my remarks would be that we do know enough to proceed to deal with existing sources that are not adequately controlled with the sorts of technologies that you describe.

I would also add that I do believe there is a need for research, particularly in new technologies. The kinds of technologies we have had to use in the past to clean up coal have generally been enormously expensive, largely the reason for the strong resistance to their installation, primarily by utilities.

For example, fluidized bed technology, particularly pressurized fluidized bed, as has been described by Mr. Wearly, is very promising. My recollection is that at one time EPA had an ongoing research program in this area in cooperation with industry. It does so no longer. Perhaps that has been shifted to the Department of Energy. I do not know.

I merely mention this to emphasize my concern that in addition to standards and the installation of control technologies there is an important role for continued research. If the premises of the World Coal Study are to be borne out.

Returning to the CO_2 matter, Professor Wilson mentioned that everything that is being said on the CO_2 problem, aside from the collection of data from the various monitoring stations, is based upon various climate models. I think that always will be the case. I don't believe that—with the exception of waiting until we may have disaster upon us—you are ever going to be able to get away in this area from taking existing data and making long-term projections from them based upon the best scientific knowledge that we have. I think that we are sort of stuck with that. We are stuck with making predictions of the impact of fossil fuel, combustion, and CO_2 a long way into the future. That is part of the problem. And I, for one, certainly do not think we should stop using fossil fuels at the present time.

ALTERNATIVES TO FOSSIL FUEL

I agree with you on instituting the best monitoring we can, but along with that, I think we need an integrated approach by our Government in concert with other nations around the world—this is clearly one where we cannot go it alone—involving the necessary environmental health regulations and the research to determine the most cost-effective ways of getting that kind of protection, continued research in better understanding the impacts of various pollutants from the use of fossil fuels, continued development of alternative energy sources, continued emphasis and new emphasis on the conservation of energy and the promotion of greater energy efficiencies here and abroad, deregulation of natural gas, and better market pricing as part of such a complex and integrated approach to the problem.

Carroll Wilson referred to the possibility of the introduction of new agricultural strains in this country, more drought-resistant strains. We certainly should be carrying on this research as insurance against the future. My understanding is that increases in agricultural productivity in this country have largely been related to the use of wild strains, wild genetic materials, mostly from the tropics—not substantially simply to fertilizers, pesticides, and other energy inputs.

So that from my standpoint, and the World Wildlife Fund's, the protection of wild species is part of this very complex picture. Reducing the loss of tropical forests, which are not found in the United States, but in which the United States has a very strong interest, is part of this complex picture.

I think we have to make an integrated attack on all of these things—which is foreign to the way Congress looks at problems, as we all know. The committee structure is not designed for integrated attacks on anything, nor is the Federal Government so organized.

Representative REUSS. Two of the first things you mentioned in your long list of what ought to be done were better monitoring, which is something that Mr. Mares is going to enlighten us on; and more coordinated international research. I have the impression that right now there isn't any coordinated international research to speak of on CO_2 and the greenhouse effect.

There is the climate, which has been meeting at Stockholm, I think. They're mainly concerned with ozone. But I don't know of any international scientific group that is specifically addressing the problem of the greenhouse effect, the heating effect of CO_2 emissions. Can somebody set me straight on that? Is there such a thing?

Mr. MARES. I know of no such international activity.

Representative REUSS. Well, I will venture to say that there ought to be somebody out there to bring it together.

Mr. MARES. WMO does, I believe, put a good deal of effort into this area, but it is not carrying out the direct research itself. This is being done, to the extent it's being done, by national governments. I would agree that there needs to be, here and in other similar areas, much better international cooperation.

SMALL NUMBER OF SCRUBBERS

Representative REUSS. Getting back to the less apocalyptic but still very serious problem of acid rain, we have said there are a number of technologies available which could surely reduce acid rain. One of them is scrubbers. I have the impression—perhaps you people can straighten me out on this—that in Japan there are thousands of scrubbers in use in coal-burning, utility, and other plants, whereas in this country there are less than 200. Does anybody have a clue on that?

Mr. SAMPLES. I can't give you expert testimony. But I can say that scrubbers are being planned at the present time on all new powerplants. That's a new source performance standard that's required.

Representative REUSS. What about the other 85 percent of plants?

Mr. SAMPLES. Well, in the circumstance of existing plants, many of them have already gone to low-sulfur coal or they are in an area where pollution is not large, and they have variances which allow them to burn some higher level of sulfur.

But I did want to make one observation. In my long tenure in the coal industry, that was a very frustrating circumstance. While I agree with almost everything that Mr. Train has said—certainly research and understanding is necessary—I do not agree that we know enough about the phenomenon of acid rain at the present time to act, and I will cite a little bit of history in respect to that.

When the Clean Air Act was first implemented, there were certain, I think, criteria documents developed, and from those criteria documents, ambient air standards were set. Then the States, as a result of that, promulgated State implementation plans which had very stringent standards. Most of this was directed at SO_2 or sulfur, which was the emission that attracted the most attention and got all kinds of press.

Well, we in our company—and not our company alone; I think other companies worked very hard on this whole area, because great dislocations and losses of jobs, transfers of jobs, increases of cost to the consumer ultimately came about in the name of the health effects of SO_2. Now, again, I qualify myself as a layman, and we have experts in our company that can testify very specifically to all the aspects and the errors in those criteria documents, which were done in haste, done poorly, in some cases maybe even fraudulently. And I say that "maybe" because I don't know that I could substantiate that. But maybe; I suspect it. We got a standard that ultimately proved, or was pretty well shown, that we could have exceeded in the name of health. I am not applying it to any other aspect, but in the name of health, SO_2 levels could have been somewhat higher in human beings, or animals, I guess, that have been subjected to no adverse effects.

Now, that was all done because we know something about it, and a tremendous cost was incurred, and a lot of economic disruption and dislocation occurred. And I think if you go around and ask experts now you could probably arrive at a consensus that the standards themselves were more severe than necessary.

Now we suddenly find ourselves with acid rain, and acid rain was probably not a new phenomenon. It's been around for a long time, and it's been up and down, and maybe our history—again, I speak as a layman, from what I can gather from other experts; I don't qualify myself in that respect—I think it would be tragic to act without knowledge and do the same kind of thing again we did before, especially at a time when we have a fair amount of economic problems in the country already, and we don't need cost increases, if we don't know that we need them for sure.

CLEAN AIR ACT CAN BE EFFECTIVE

Now, what we have in place in the Clean Air Act—and let me say that I am saying this not as a representative of the National Coal Association or the American Mining Congress, but I am saying it on behalf of my own company and our position—is that we think that the new source performance standards as they now exist are a very effective tool for controlling sulfur emissions for future coal-burning plants. In only a matter of not too many years the existing plants that do not scrub will phase out and the new plants with the equipment that reduces emissions to very low levels will be in place. And so, you will still see—let me see, maybe if not a reduction, certainly not an increase in emissions.

Representative REUSS. How long does that phaseout of current plants without scrubbers take?

Mr. SAMPLES. I don't have the data at hand, but I would say that certainly by the turn of the century you will see most if not all of them gone.

Representative REUSS. Mr. Train, in your judgment, does the Clean Air Act now on the books, if adequately enforced, permit a substantial reduction in sulfur oxide and nitrogen oxide emissions from utility plants?

Mr. TRAIN. I think it has, in fact, so resulted. But I think, as has been pointed out, about 85 percent of the sources of sulfur are existing sources, to which the new source requirement does not apply.

Representative REUSS. But the Clean Air Act does apply.

Mr. TRAIN. Of course. But the Clean Air Act is really focused on ambient air quality standards. That is the level of pollution in the area around its source, and does not, in my view, adequately address the problem of long-range transport. I think that's been fairly well recognized.

There is continuing argument, I would agree, over long-range transport issues. I certainly would not say there is no argument over the upper atmosphere chemical phenomenon that produced these particulars. My own feeling is that it is pretty plain that the current, quite significant buildup in acidity in the lakes of the northeast, especially northern Canada and Nova Scotia, is directly related, perhaps, to other things as well, but certainly directly related to the production of SO_2 by powerplants in Ohio and elsewhere in the region.

Representative REUSS. Are you familiar with any of the legislation now before the Congress on this specific problem?

Mr. TRAIN. Not really, Mr. Chairman.

I would say, with respect to all of the testimony here, I doubt that any of us are very much experts on the criteria documents, what went into them, or what the proper levels of SO_2 standards should be.

The National Air Quality Commission did not recommend any reduction in SO_2 standards. There is certainly some scientific suggestion that perhaps standards are not high enough.

Now, I'm not making that claim. All I would say is that there is argument on both sides. I didn't want Mr. Samples to have it all one way.

Mr. SAMPLES. I think I qualified, that I am not an expert, but I am very close to this. We could debate it for a long time and maybe not come to a conclusion.

Representative REUSS. This committee is not a scientific committee, and we're not trying to legislate on SO_2. We are trying to list the pros and cons of coal as a reindustrialization catalyst.

MINE HEAD ELECTRIC GENERATION

Let me turn to another issue, Mr. Samples. What about mine head electric generation? Mr. Wearly had something to say about that, or perhaps you did. But it would seem to the layman that generating electricity, under proper safeguards, of course, at the mine head and then shipping the finished electricity is one way of using coal. What are the things to be said for and against that?

Mr. SAMPLES. Of course, a fair amount of that is done.

Representative REUSS. Some is done.

Mr. SAMPLES. Yes; it is already being done.

I think in circumstances where the energy does not have to be transmitted great distances, it has great value.

But I think that most utilities will site their plant in what they would term the most economical location and take into account the transmission line costs to deliver the power versus the cost to move the coal to the plant or move the water that's so necessary to cool the plant.

So there are several factors that get into the whole scheme of things that deal with the economics of the delivery of the product.

Representative REUSS. Hasn't there been some new technology in recent years which causes less electricity and heat in the transmission process than used to be the case?

Mr. SAMPLES. Yes, the technology has developed. And again, I'd have to qualify myself—I'm a layman in this respect—but some technology is available that I have heard of, DC versus AC transmission over long distances, cryogenics, things of that nature, extra-high voltage transmission, that do offer some promise. I assume those things are now being taken into account when plants are cited.

DELAYS IN HARBOR DREDGING

Representative REUSS. On another subject, Mr. Samples, you pointed out that regulation has caused unconscionable delays in applications for harbor dredging. Those delays have been caused, have they not, not only by Federal authorities, but also State and local authorities who are also in on the regulatory process?

Mr. SAMPLES. Well, I think maybe the one that's very important to us at the present time who ship coal through the Eastern Seaboard, which would be a dredging of the harbor of Baltimore, also a dredging at the harbor at Hampton Roads. The dredging has been delayed because the process, as it has been accomplished before, was done by the Government, and it was necessary to have an appropriation to allow that to happen. And, of course, the appropriation hasn't happened.

On the way to getting final approval and there were certain lawsuits with respect to where the dredged materials would be placed.

Of course, now we have the circumstance where Mr. Reagan says the users should pay. Of course, the coal industry stepped out a long time ago and said, "You know, we understand, if we're going to get anything done, we'd better get the message."

So, we're saying that, rather than pay it all, we should find some way to share. We're perfectly attuned to that. But we also say that we ought not to take two decades to get the job done.

Representative REUSS. You also have been extremely helpful and very patient as we approach the end of this morning's hearing.

Before I declare us in adjournment, however, does anybody have anything additional which he would like to present? Or have you found any of your colleagues statements particularly infuriating and you want to answer before we close?

U.N. INVOLVEMENT ON CO_2 ISSUE

Mr. MARES. I might reflect on one thing. I do understand that the United Nations Environmental Program Group is designing an en-

vironmental assessment program related to the CO_2 issue—I do believe there is at least an international effort to look at the CO_2 issue.

Representative REUSS. When you flesh out that answer to the earlier question, tell us a little more about that.

Mr. MARES. All right. I will be happy to do so.

[The following information was subsequently supplied for the record:]

INTERNATIONAL ACTIVITIES RELATED TO RESEARCH REGARDING GREENHOUSE EFFECT

The World Meteorological Organization, the International Association of Meteorology and Atmospheric Physics and Scientific Committee on Problems of Environment/United Nations Environmental Program represent international groups involved in carbon dioxide research. The World Meteorological Organization is performing in-depth analysis of atmospheric carbon dioxide data collected in the monitoring network. The Scientific Committee on Problems of Environment/United Nations Environmental Program is designing an environmental assessment program related to the carbon dioxide issue. The Department of Energy is currently working with the Commission of the European Communities to develop a coordinated exchange of scientific research data.

The Department of Energy (Office of Energy Research) is the lead agency for carbon dioxide research in the U.S. Government. It works with the National Climate Program Office and chairs a subcommittee of this office—the Interagency Committee on Carbon Dioxide and Climate. The member agencies of the Interagency Committee on Carbon Dioxide and Climate include the Department of Energy, the Department of Commerce, the Department of the Interior, the Department of Agriculture, the Department of Defense, the Department of Health and Human Services, National Aeronautics and Space Administration, and the Environmental Protection Agency. This committee has the following functions and responsibilities: interagency budget planning; program review; information dissemination; and coordination of research. Through this committee the entire U.S. Government's carbon dioxide research activities are coordinated to insure that the key questions are being researched and results are quickly disseminated throughout the government.

The Department of Energy has also established an information system at the Oak Ridge National Laboratory to coordinate networking of data bases on a worldwide scope. Dr. Trivelpiece, the Director of the Office of Energy Research, has recently had discussions in Japan as to Japanese cooperation and sharing of scientific information on the carbon dioxide issue. This international coordination and cooperation will be expanded in the next few years.

UTILITY RATE REGULATION

Mr. SAMPLES. Mr. Chairman, I'd like to allude to one thing that we perceive in the industry that impedes the burning of coal and the development or the putting in place of new plants to burn coal. I'm not sure exactly how this committee might reflect on it or what its role might be, or the Federal Government's role will be. But the problem is public utility commissions in the various States.

As you know, the mechanism for establishing rates by the utilities in the various areas of operations is to seek approval from the public utility commission. And the particular accounting procedures that are used are not conducive to setting up levelized rates which would encourage the raising of capital and building new plants.

It's far easier to pass through increased fuel costs in the form of oil and pass that along to the customer than it is to get the kind of rate adjustment that would be based upon raising new capital for a plant that would produce cheaper energy. This is a bottleneck that prevents the utilities from being able to raise the capital to move forward with investments.

It is a subject that might be worthy of the attention of the Federal Government to look over the States in the same way they are doing with slurry pipeline transportation to see that it is treated properly.

It might be the role of the Federal Government to look over public utility commissions ratemaking process, with respect to capital-raising, for the utilities.

Representative REUSS. To summarize what we've heard this morning, it does lead to my tentative feeling that coal is indeed a candidate for an important role in America's reindustrialization, and it does have many of the catalytic qualities that we look for in admitting industries to that temple.

It would appear as if there needs to be somewhat more recognition by our Nation of the important role coal has to play in the next 20 to 30 years.

It would seem that somewhat better sorted out governmental leadership, along with the private sector, and at all levels of government, is needed.

And finally, it would seem that more certain safeguards need to be taken against some of the negatives, some of the hazards of the enhanced use of coal, largely in the field of environment and safety, many of those things touched on by Mr. Train.

Your testimony, taken together, has been invaluable, fairminded, exhaustive, and we're grateful to you. In some cases, you're going to help us with some additional information.

And to the extent that any of you have additional thoughts, the record will remain open for a reasonable time to receive it.

On behalf of the committee and the Nation, thank you, gentlemen, very much. The committee stands adjourned.

[Whereupon, at 1 p.m., the committee adjourned, subject to the call of the Chair.]

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APPENDIX

STATEMENT OF HON. JENNINGS RANDOLPH, A U.S. SENATOR FROM THE STATE OF WEST VIRGINIA

Coal must relieve our immediate dependence on foreign-based energy by replacing oil in all types of existing applications. In the long term, it will serve as the base feedstock of massive gasification and liquefaction facilities assuring our independence from Mideast fossil fuel. Through the dramatic increase in coal exports that is expected to occur, we look toward improvement in our balance of payment ratio. Coal touches many American industries so completely we also look to coal to spur increased investment and capital spending.

In spite of the existence of our reserves and their importance to the Nation's future, nine years after the Arab oil embargo exposed our vulnerable energy position and over thirty years after I warned of it, the anticipated coal boom has yet to arrive.

I feel that coal production will increase in the years ahead. I, however, also have doubt as to whether existing Government policies will permit a rate of increase equal with the coal industry's true potential for growth. The question is then, why has this new coal age failed to arrive? Largely it is because America's expectations of the coal industry, when compared to the regulatory climate it is expected to operate within, makes our expectations of the resource unrealistic. Action taken in the budget reconciliation measure highlights our inconsistent vacillating national policy toward coal. That legislation repeals the off-gas provision of the Powerplant and Industrial Fuel Use Act which requires utilities in 1990 to stop burning natural gas to generate electricity. The Reagan administration also recently reversed an Executive order issued in 1980 calling for conversion of all Federal facilities to use coal.

If a new coal age is to arrive the 97th Congress and the Reagan administration together must be committed to discovery and resolution of conflicts that result from the pursuit of energy, economic and environmental objectives at the same time.

We must set realistic guidelines to retain protection of the environment during America's new coal age. We must modify policies which prevent or delay the assembling of and production from minable coal reserves. We must adjust requirements which will prevent siting and delay financing, construction, and operation of facilities which turn coal into energy. We must provide incentives to increase investment capital so utilities and industries can convert facilities to coal more quickly.

Since the midseventies forty-two utility generating stations have voluntarily converted to coal. I know of eleven others that are now planning to convert. In fact, in reading today's edition of the Washington Post I was gratified to note the Virginia Electric and Power Company plans to convert four more oil burning generating plants to coal, saving another 400,000 barrels of oil a year. The article states that "two plants are in Portsmouth and two are at Possum Point near Dumfries. VEPCO officials said they expect to complete the $85 million switch by 1986. About $80 million would go for environmental-protection equipment."

There are, in addition, forty-seven generating stations which need to take advantage of the provisions in the 1978 Fuel Use Act, to make successful conversions to coal. The result of these other conversions would displace 700,000 barrels of oil per year with 70 million tons of domestic coal production.

The Reagan administration, however, has begun to dismantle the office of fuels conversions in the Department of Energy responsible for implementation of the Fuel Use Act.

A recent market analysis by Frost and Sullivan indicated it would cost $1.1 billion for pollution control equipment to convert fifty-four electrical units to

coal. The cost study revealed a potential expenditure of $1.7 billion for coal conversion equipment and services, and would create a $4 billion total market in direct and indirect investments. The study calculates the conversions would cause a $1.2 billion investment in coal mining, $480 million in new railroad hopper cars plus $340 million for locomotives.

The fuel savings from coal conversions would be approximately $2 billion annually. The savings would total the entire capital investment to be made by the utilities.

Government action should include attention to a delivery system for coal. Increasing exports markets will not be realized without improvement to our ports, roads, rails and waterways.

We cannot ignore the rebuilding task involving the coal industry itself. Problems remain from the period when coal had far less appeal than it does today. Less coal was removed from America's mines in the first half of the sixties than in the late forties. Production in the subsequent years did not increase significantly. Those years of inactivity created a void in the industry's labor force and reduced the development and use of technological innovation. We in Public service must encourage prompt resolution of labor problems through enlightened negotiating by all parties to assure that situations such as last year's coal strike, does not erode confidence in our ability to deliver coal. We in public service must continue to support Government participation in both mining and process research and development to increase coal production and utilization.

It is essential that we recognize the changing economic climate in which the coal industry will be operating over the next few decades. People involved in the industry must not only be able to correctly analyze coal markets, but must understand the entire energy market. They must understand specific requirements of utility and industrial coal users and provide them with the specific grades of coal to meet the applicable environmental standards. They must also understand that in the future the Third World nations which possess significant coal reserves will eventually develop them, thus increasing competition for coal export market.

In the absence of policy direction from the Congress and administration, utilities and industries will continue to delay meaningful significant improvement toward coal. Exporters will hesitate to enter long-term supply contracts until there is certainty that our transportation system can move large amounts of coal. The prospective owners of major gasification and liquefaction plants will delay construction decisions until Federal policies relating to financing supports are firmly agreed to.

If we in the legislative and executive branches do not accept the responsibility of developing firm coal policy direction, then we have failed to take the first step in probably the largest industrial transformation in history—a transformation in which coal substitution would provide the necessary lead time for other energy alternatives, principally solar, to develop and make tangible contributions to domestic energy supply.

ACID PRECIPITATION: A SERIOUS AND GROWING ENVIRONMENTAL PROBLEM

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ISSUE DEFINITION

Acid precipitation may be one of the most significant environmental problems of the new decade. Its potential for damage to crops, forests, soil fertility, lakes and fish populations, and manmade materials appears great.

Acid precipitation results from oxides of sulfur and nitrogen reacting with water vapor in the atmosphere. These pollutants are produced primarily by the combustion of fossil fuels in powerplants and automobiles, and in smelting processes.

Acid precipitation is expected to increase with greater coal use. The presently observed increased acidity of rainfall in the U.S. has occurred during a period (1950-1977) in which coal use expanded by 30%. Now, with present projections indicating a near doubling of coal use between 1977 and 1990, the problem will most likely become significantly worse, especially in view of the projected 224% increase in the use of coal for electricity generation during the same period. The problem could be exacerbated even further through conversion of existing oil-fired powerplants to coal. These converted plants may not be held subject to stringent new-source performance standards. Rather, they could be much less tightly controlled under State Implementation Plans.

At least partial control of pollutants causing acid precipitation is possible but at considerable cost. Scrubbers can be installed on powerplants to remove 90% of the effluent sulfur oxides. Nitrogen oxides control is less well developed but control techniques such as fluidized-bed combustion for powerplants and 3-way catalysts for automobiles are promising and well along the way toward development. Coal washing also appears to offer the opportunity for significant reduction in sulfur emissions.

The potentially severe environmental impacts of fossil-fuel burning, especially those associated with acid rain, have serious implications for national energy policy. In view of the country's need to reduce its dependence on foreign oil, it appears necessary to use much greater quantities of coal in the near- and intermediate-term. If this is so, to what degree should pollution controls be required? More specifically, is it necessary to impose stringent Federally mandated emission standards on existing (and converting) coal-fired powerplants similar to those already in place for new sources? If so, what will this cost and how should these costs be borne? If these costs are too prohibitive or if the technology proves to be unavailable, what other resources are available? Does the nuclear option need reexamination? Are we moving sufficiently rapidly toward development of maximum use of renewable resources?

BACKGROUND AND POLICY ANALYSIS

Rainfall and snowfall more acidic than normal is considered "acid precipitation." Normally rainfall is somewhat acidic due to the reaction of atmospheric moisture and carbon dioxide. Thus, normal rainfall has a pH of 5.7. pH is a measure of the acidity or alkalinity of a substance. On a scale of 0 to 14 pure water has a pH of 7.0. The lower the number the more acid a substance is; for example, lemon juice and vinegar have pH's of between 2 and 3. At the opposite end of the scale, ammonia and lye, two

strong bases, have pH's in the 12 and 13 range. It is important to realize that the pH scale is logarithmic -- that is, each number on the scale differs by a factor of 10 from its neighboring number. Thus, a pH of 6 is 10 times more acid than pure water, while a pH of 5 is 100 times more acidic, a pH of 4 is 1000 times more acidic, 3 -- 10,000 times, and 2 -- 100,000 times more acidic.

How acidic is acid rain? Rainfall in the eastern United States, eastern Canada, and most of Scandanavia is routinely in the 4 to 5 range, often falls between 3 to 4, twice has been recorded as low as 2.4, and once, in Wheeling, West Virginia, was recorded at an all-time low of 1.5. Rainfall in the western United States is usually "normal," but in some areas, particularly near Los Angeles, San Francisco, the Seattle-Takoma area, and in the newly developing megalopolis area along the Front Range of the Rocky Mountains (Colorado Springs-Denver-Boulder-Fort Collins) the pH has been measured in the 4.0 range. Recent reports also indicate that the Boundary Waters Canoe Area near the U.S./Canadian border is suffering from increased levels of acidity in precipitation.

Causes. Sources are not completely identified but in the eastern U.S. apparently about 60% is in the form of acid sulfates, 30% acid nitrates, and 10% acid chlorides and others. In the West it appears that nitrates are predominant. Acid sulfates are thought to be transformation products of sulfur oxides coming from industrial sources such as electric powerplants, smelters, coking ovens, and others. Similarly, acid nitrates are believed to be transformation products of nitrogen oxides which originate not only in stationary sources such as electric utility powerplants, but also in mobile sources such as automobiles, and possibly from agricultural fertilizers.

In each case, the sulfur or nitrogen oxide pollutants rise into the atmosphere and travel with prevailing winds for distances possibly extending to thousands of kilometers, all the while reacting with water vapor and changing into acid sulfates and nitrates and eventually coming back to earth in the form of acid precipitation.

Although much of the pollution emitted by powerplants and other industrial and mobile sources undergoes this long-range transport and transformation, about one-half may return to earth within 30 to 50 kilometers of the source. Therefore the acid deposition problem is also one of local concern.

A recent DOE study suggests that local oil-burning sources may be contributing significantly to the acid rain problems. The report, entitled "Acid Rain: The Impact of Local Sources," claims that sulfur dioxide from local oil-burning sources may be converted to sulfates through reactions catalyzed by vanadium released in the same oil combustion processes. The report goes on to suggest that it may not be cost effective to clean up a few of the largest coal-fired powerplants through use of scrubbers when it is really the many smaller local oil-fired sources which cause most of the problems.

Effects of Acid Precipitation. Acid rainfall and snowfall can cause a number of serious environmental problems including damage to crops and forests, decreased soil fertility, sterility of certain lakes, and corrosion to manmade materials.

Certain particularly susceptible lakes, found primarily in the Adirondack Mountain region of the United States, in eastern Canada, and in southern Sweden, have become devoid of all fish life. These lakes are located in

geological areas where there is a lack of natural neutralizing minerals, for example, limestone. Thus, the lakes continue to get a heavy dose of acid, particularly during the spring run-off from melting snow, and have no means of recovering naturally.

Adirondack lakes have gone from an average pH of about 6.8 in the 1930s to about 4.8 in 1975. Apparently as a result of this, between 100 and 200 are now devoid of fish. Based on limited sampling and preliminary sensitivity analysis, Canadian officials believe that between 2,000 and 4,000 lakes in Ontario are similarly "dead" and that tens of thousands more are at risk. The species of fish in these lakes simply cannot reproduce at pH's below about 5.0.

There is also considerable evidence that, under conditions of increased acidity, certain elements, normally locked into minerals in the soil and lake bottom sediments, are mobilized. Aluminum is one of these and it appears that the sudden increase in the concentation of aluminum in a lake during the spring melt of the snowpack is a major cause of damage to fish populations. Mobilization of mercury from lake bottom sediments is another potentially serious problem.

This mobilization of heavy elements could have serious implications for drinking water supplies. In addition, the human health effects of metals leaching from pipes in drinking water delivery systems is a potential but little discussed problem.

Plant growth is also affected by acid precipitation. In addition to reduction in yields due to leaching of nutrients from the soil, direct damage to leaves from acid deposition and increased predisposition of plants to infection by bacterial and fungal pathogens have been verified. Because of effects such as these, Sweden estimates a 2 - 7% reduction in forest growth between 1950 and 1965. Recent studies from Norway, however, indicate no decrease in forest growth due to acid rain. In fact, a few laboratory studies, including one which was EPA sponsored, have reported an increase in growth for certain plants due to additions of artificial "acid rain." These results are believed to be due to the addition of sulfur and nitrogen. It is generally recognized, however, that adding sulfur and nitrogen in the form of an acid rain is not the best way to obtain the necessary plant nutrients, and that potential damages far exceed potential benefits.

Damage to manmade materials also can be considerable. No firm estimates of damage are available, but damage to automobile paint in the Los Angeles area, and continued, accelerating corrosion-erosion of the world's buildings and monuments have been reported. Notable among those receiving attention are the Acropolis and Parthenon in Greece and Cleopatra's Needle in New York City. These, and other treasures from antiquity have been degraded more in the last 50 years than they were in the preceeding 2000. At least part of this degradation is believed to be due to acidic air pollution.

Actions. Because it is a global problem, considerable discussion of the acid precipitation problem has occurred in international forums. For example, in November 1979 at the International Convention on Transboundary Air Pollution in Geneva, 33 countries including the United States, Canada, Soviet Bloc countries, and those in the United Nations' Economic Commission for Europe, pledged to "limit, reduce, and prevent all forms of air pollution." They singled out transfrontier hazardous emissions and acid rain for special attention. Although this agreement calls for cooperative research, establishment of a monitoring network, and exchange of information,

it contains no control strategies and, therefore, has no real authority.

The United States and Canada are striving to develop a bilateral agreement on transboundary pollution that will focus on acid precipitation. On July 26, 1979, the two governments issued a joint statement in which they declared their intention to move forward formal negotiations aimed at reaching an agreement. On Aug. 5, 1980, a memorandum of intent was signed by both governments in which they agreed to establish joint scientific working groups in preparation for the start of formal negotiations scheduled now for June 1981. The governments also agreed to "promote vigorous enforcement of existing laws and regulations as they require limitation of emissions from new, substantially modified and existing facilities." They also resolved "to protect the environment in harmony with measures to meet energy needs and other national objectives."

In January 1981, Canada announced plans to embark upon a $500 million project to reduce sulfur emissions by 43% in the province of Ontario. These plans include: installation of scrubbers at two 500,000 KW powerplants; installation of special burners at three generating stations to reduce nitrogen oxide; purchasing electricity from outside the area when necessary; and increased use of low-sulfur coal. This action is taken not only to help clean up Canada's contribution to acid precipitation but also to demonstrate Canadian concern over the situation and to convince the U.S. to avoid taking action which might worsen the problem, such as weakening the Clean Air Act or converting powerplants from oil and gas to coal without requiring pollution controls.

Meanwhile, the United States is attempting unilaterally to do something about the problem.

In general, the 1977 Clean Air Act Amendments provide for attainment of primary air quality standards designed to protect human health by 1982. However, there is no fixed date for attaining the secondary air quality standards which are set at levels to protect plants, animals, materials, and aesthetics from effects of air pollution. Effects from acid precipitaion generally fall into this category.

Also, under the Clean Air Act Amendments of 1977, EPA has adopted emission standards for new coal-fired powerplants. These standards, established to implement the policy of requiring the best available control technology on all new coal-burning plants, will reduce emissions of sulfur dioxide from new plants by 55%, nitrogen oxides by 20%, and particulates by 70% compared to current standards. For sulfur, these standards will require removal of at least 70% of the sulfur from all coal, regardless of its sulfur content, and 90% from high-sulfur coal.

Unfortunately, it will be many years before this policy will pay dividends. Most of the pollution will continue to come from older, largely uncontrolled plants. In March 1979, only 8% of all coal-fired electricity in the United States came from powerplants with scrubbers. Even in 1995, plants now in existence will account for 73% of sulfur oxide emissions. Because of the continued existence of older, uncontrolled plants, and due to the new push to dramatically increase the use of coal, EPA predicts that sulfur dioxide levels will continue at present levels while nitrogen oxides emissions will rise by about 50% over the next 20 years. The increase in nitrogen oxides is due primarily to the inadequate state of the art in stationary source nitrogen oxide control at present.

Several measures for dealing with the acid rain problem have been suggested, both through the Clean Air Act and by other means. These include the following possible EPA actions using Clean Air Act authority:

1. Develop a sulfate standard.

2. Tighten the secondary SO2 standard.

3. Set a standard for respirable (very fine) particulates.

4. Tighten the definition of modification or reconstruction of existing sources to place more under the stringent New Source Performance Standards.

5. Seek to control interstate pollution through section 126 of the Clean Air Act, by clarifying its role and simplifying and better stating its procedural requirements.

6. Use section 115 (Control of international pollution) to tighten State Implementation Plans (SIP's) where States are adversely affecting the environment or public health of a foreign country.

7. Tighten policy regulating stack height (section 123).

8. Improve enforcement monitoring (section 114) to ensure that major sources are complying with existing limitation.

9. Use improved modeling techniques to upgrade quality of State Implementation Plans.

Other actions could include:

1. For existing sources, establish a uniform emissions limit beyond which no one could go (rather than a plant-by-plant emissions limit.)

2. Set an emissions cap on a statewide basis (a kind of statewide "bubble" concept) to obtain overall reduction in SOx and NOx but, at the same time, give States flexibility to meet it.

3. Require coal washing -- a pre-burn process which eliminates approximately 30% of the sulfur in some coals.

4. Require "least emissions" plant scheduling by utilities in which cleanest plants are routinely started up first and used more often. (Most utilities now schedule plant used on a cost basis, using the most economical plants most often. Unfortunately, these cheaper-to-run plants are usually older and more polluting.)

Former President Carter also attempted to address the problem of acid rain. In his Aug. 2, 1979, message on environmental priorities and programs he established a 10-year comprehensive Federal acid rain program to be planned and managed by an Acid Rain Coordination Committee. EPA and USDA co-chaired this committee with CEQ acting as executive secretary. Other members included the National Science Foundation, the White House Office of Science and Technology, and the Departments of State, Interior, Commerce, and Energy. The committee was to develop an assessment program to include basic and applied research on acid rain effects, trends monitoring, and control measures. Also, it was to establish links with industry to promote

cooperative research wherever possible. In its first full year of operation, the program was to have $10 million in reprogrammed research funds. CEQ was to have produced a report by early 1980 outlining this assessment program. The Acid Rain Coordinating Committee and its work has been replaced by the Acid Precipitation Task Force, established by Title VII of the Energy Security Act, and as described below.

The electric utility industry also recognizes the seriousness of the acid rain issue. Through the Electric Power Research Institute (EPRI), the industry has provided over $5 million for acid rain research during the past three years and anticipates spending another $10-15 million during the next five. While recognizing that acid rain is falling and that it can cause serious ecological damage, the utility industry maintains that both the extent of ecological damage and industry's contribution to the overall problem are largely unknown. The bases for these statements are primarily scarce and sometimes conflicting data.

To resolve the issue, the electric utility industry supports continuing and increased research into: (1) the magnitude of ecological damage; (2) the geographical extent of acid precipitation; (3) the role played by long-range transport of pollutants; and (4) the chemistry of formation of acid rain. President Reagan's Administration did not propose specific changes to the Clean Air Act. However, in a recent set of "principles" that would guide it in working toward amending the law, the Administration proposed that research on acid precipitation be accelerated, but did not support any regulations.

Public Law. Energy Security Act (P.L. 96-294). Title VII of this Act establishes a comprehensive 10-year program to identify the causes and effects of acid precipitation and to identify actions to limit or ameliorate its harmful effects. The Act creates an Acid Precipitation Task Force, having the heads of the Department of Agriculture, the Environmental Protection Agency, and the National Oceanic and Atmospheric Administration as joint chairmen. Other members of the task force include:

(1) one representative from each of the Departments of Interior, Health and Human Services, Commerce, Energy, State; the National Aeronautics and Space Administration; the Council on Environmental Quality; the National Science Foundation; and the Tennessee Valley Authority;

(2) the directors of the four national laboratories -- Argonne, Brookhaven, Oak Ridge, and Pacific Northwest; and

(3) four additional presidential appointees.

The national laboratories are to function as a research consortium and are to report to and take direction from the joint chairmen.

The administrator of the National Oceanic and Atmospheric Administration is to serve as director of the research program conducted under this title.

The task force is to develop a comprehensive research plan, which is to include programs for:

(1) identifying the sources of atmospheric emissions contributing to acid precipitation;

(2) establishing and operating a nationwide long-term monitoring network to detect and measure levels of acid precipitation;

(3) research in atmospheric physics and chemistry to facilitate understanding of the processes by which atmospheric emissions are transformed into acid precipitation;

(4) development and application of atmospheric transport models to enable prediction of long-range transport of substances causing acid precipitation;

(5) defining geographic areas of impact through deposition monitoring, identification of sensitive areas, and identification of areas at risk;

(6) broadening of impact data bases through collection of existing data on water and soil chemistry and through temporal trend analysis;

(7) development of dose-response functions with respect to soils, soil organisms, aquatic and amphibious organisms, crop plants and forest plants;

(8) establishing and carrying out system studies with respect to plant physiology, aquatic ecosystems, soil chemistry systems, soil microbial systems, and forest ecosystems;

(9) economic assessments of (A) the environmental impacts caused by acid precipitation on crops, forests, fisheries, and recreational and aesthetic resources and structures, and (B) alternative technologies to remedy or otherwise ameliorate the harmful effects which may result from acid precipitation;

(10) documenting all current Federal activities related to research on acid precipitation and ensuring that such activities are coordinated in ways that prevent needless duplication and waste of financial and technical resources;

(11) effecting cooperation in acid precipitation research and development programs, ongoing and planned, with the affected and contributing States and with other sovereign nations having a commonality of interest;

(12) analyzing the information available regarding acid precipitation in order to formulate and present periodic recommendations to the Congress and the appropriate agencies about actions to be taken by these bodies to alleviate acid precipitation and its effects.

Furthermore, subject to certain limitations, the plans to be developed by the task force are to include provisions for financial resource and technical program management of Federal acid precipitation research and development.

The comprehensive plan is to be submitted in draft form to Congress, and for public review, within six months after enactment of the Act (Dec. 31, 1980). It is to be available for public comment for 60 days after submission and is to be presented to the President and to Congress 45 days later.

The plan is to be the basis for authorizations and appropriations for the remaining 10 years of the program.

Currently, the law authorizes for appropriation to the National Oceanic and Atmospheric Administration $5 million for FY81 to carry out the mandates of Title VII. $45 million is authorized for the remaining nine years of the program, but funding is to be through annual appropriations.

The task force is required to report annually, by January 15, its progress and recommendations. In the 97th Congress, the House Subcommittees on Oceanography and on Fisheries and Wildlife Conservation held a hearing on the progress of this task force on June 11, 1981.

LEGISLATION

In the 97th Congress, several bills dealing with acid precipitation have been introduced, most amending the Clean Air Act in some way.

S. 1706. Introduced by Sen. Mitchell and others, this bill establishes a region called the "acid deposition impact region" which includes the 31 States (plus the District of Columbia) bordering on or east of the Mississippi River. Within this region, emissions of sulfur oxides and nitrogen oxides from stationary sources are not to grow beyond those levels actually emitted as of Jan. 1, 1981. Furthermore, sulfur dioxide emissions are to be reduced over a 10-year period by 10 million tons from levels emitted in calendar year 1980. Each State's share of the 10 million ton reduction is to be determined by multiplying that figure by the ratio of that State's actual utility emissions in excess of 1.2 pounds of sulfur dioxide per million Btu's (the new source performance standards for coal-fired power plants) to the total actual utility emissions in the 31-State region in excess of the 1.2 standard. Interstate agreements to reallot reduction requirements are allowed. The States are to adopt enforcement procedures within 2 years, after which the EPA Administrator is to approve them within 4 months, providing: (1) the measures call for enforceable, continuous emission reduction; (2) they establish emission monitoring; and (3) they are adequate to achieve the reduction goals. The emissions limitations and schedules then become part of each State's Implementation Plan. Should a State fail to comply with the above, Federal preemption is to follow. Enforceable emission reduction programs are defined as: least emissions dispatching; early retirement of older polluting sources; investments in energy conservation measures which lead to emission reductions; trading of emission reduction requirements; and precombustion cleaning of fuels. Reductions in oxides of nitrogen can be substituted for sulfur dioxide reductions on a 2 to 1 basis by weight.

S. 1709. This bill, introduced in the Senate by Sen. Moynihan, and its companion bill in the House, H.R. 4936, introduced by Rep. Scheuer, also establishes an "acid precipitation mitigation region," identical to that specified in S. 1706. In these bills, over a 10-year period sulfur dioxide emissions from stationary sources in each State within the region are to be reduced by 85% from the actual 1980 sulfur dioxide emission level, ignoring emissions from sources that are complying with new source performance standards. Limits are placed on reductions required for States with relatively low average statewide sulfur dioxide emission rates (2 pounds sulfur dioxide per million Btu's, or less). EPA is to establish the emission reduction requirements which will then become part of the State's Implementation Plan. The plan will include schedules, timetables, and other enforceable measures. Trading of emission reductions, as well as other emission reduction measures similar to those mentioned in S. 1706 are encouraged. Nitrogen oxides reductions can be substitued for SO2 reductions, on a 2 to 1 basis, as in S. 1706.

H.R. 4816. Introduced by Rep. D'Amours, this bill also establishes the same 31-State (plus D.C.) acid mitigation area as specified in the previously mentioned bills and requires emission reductions of SO2 reductions achieved

through State Implementation Plans. However, the amount of the reduction is specified as an amount equivalent to the reduction which would be achieved if certain requirements were applied to certain specified sources.

These sources are divided into two groups: the first group includes the 50 electric utility steam generation units in the mitigation area which had the highest annual emissions of SO2 for the calendar year 1980 and which are not subject to new source performance standards; the second group includes all other electric utility steam generating units in the area having a capacity of more than 100 Megawatts and which are not subject to new source performance standards. For the units in the first group, an 85% reduction in baseline emissions is to be applied (but not less than 0.6 pounds SO2 per million Btu's) or an emission standard of 1.2 pounds SO2 per million Btu's (averaged over 30 days), whichever is lower. For the second group an emission standard of 1.2 pounds SO2 per million Btu's applies.

These calculations are to be used to determine the levels of emission reductions which are to be achieved through State Implementation Plans. Emission reductions are to be achieved by 1990. Schedules are to be developed which will achieve substantial reductions in each of three three-year periods.

Baseline emissions for any unit are to be the lesser of: (1) actual emissions of SO2 during calendar year 1980; or (2) the allowable emission limitation (if any) applicable to that unit under the applicable State Implementation Plan in effect on Dec. 31, 1980. State Implementation Plans can call for a number of emission reduction techniques including but not limited to: trading of emission reductions; energy conservation actions resulting in lower emissions; early retirement of generating units; and others. Sources would be required to conduct continuous emissions monitoring. This bill also establishes an EPA-administered emissions reduction credit program with five regions in which emission reductions are to be formally recorded, banked, traded, and sold.

H.R. 4829. This bill, introduced by Rep. Moffet and others, is similar to S. 1706 in that it calls for a 10 million ton reduction in SO2 emissions within 10 years to be accomplished through State Implementation Plans and has a Federal preemption provision (if necessary). However, it also has a provision establishing an emission reduction credit program similar to that found in H.R. 4816.

Others. Other bills, H.R. 3471 (Rep. Broyhill et al.), H.R. 4830 (Rep. Gregg et al.) and H.R. 5055 (Rep. Rahall et al.) call for accelerating the research program on acid precipitation originally established in Title III of the Energy Security Act of 1980 (P.L. 94-294) by reducing the program timeframe from 10 years to 5.

H.Con.Res. 152 expresses Congress's concern over the international aspect of acid precipitation and calls for the establishment of a North American Air Quality Commission.

H.R. 1031 indirectly affects the acid precipitation problem by calling for grants for sulfur removal at coal burning powerplants, and for coal preparation (coal washing) facilities.

Finally, S. 723/H.R. 946 would amend the Act to control air pollution in border areas of the U.S. and countries contiguous to the U.S.

Several committees have held hearings on the problem. The Senate Environmental and Public Works Committee discussed it in the context of proposed amendments to the Clean Air Act during its May and June hearings; the House Subcommittees on Oceanography and on Fisheries and Wildlife Conservation held a joint hearing on the progress of the Interagency Task Force on Acid Precipitation on June 11; and the House Subcommittees on Human Rights and International Organizations and on Inter-American Affairs held a joint hearing on U.S.-Canadian relations and acid rain on May 14.

Other hearings dealing at least in part with acid precipitation include several by the House Committee on Science and Technology: on the Clean Air Act (May 19, 20, and 28, 1981); field hearings on acid precipitation (at Lake Placid, Sept. 18 and 19, 1981); a technical briefing on new findings on acid precipitation (Nov. 19, 1981); and on H.R. 4830 and H.R. 5055 (Dec. 9, 1981).

The House Committee on Energy and Commerce held hearings dealing with acid rain (Oct. 1, 2, 6, and 20).

The House Merchant Marine and Fisheries Committee held hearings on the progress of the Interagency Task Force on Acid Precipitation (June 19, 1981).

Statement of Rene H. Males, Director, Energy Analysis and Environment Division, Electric Power Research Institute

Introduction

My name is Rene H. Males and I am Director of the Energy Analysis and Environment (EA&E) Division at the Electric Power Research Institute (EPRI). EPRI is the research arm of the electric power industry and is funded by voluntary contributions from the individual operating utilities in the U.S. The EA&E Division is one of six technical divisions at EPRI. It is charged with developing the fact base and the methods by which EPRI determines the R&D needs of the industry to be carried out by the other five divisions whose research is primarily hardware-oriented.

The question being posed by the committee as to what should be the nature of private sector-government cooperation with regard to coal-use is an important one for the U.S. economy. This relatively brief statement will not attempt to answer this question. Rather, the purpose of the paper is to introduce EPRI's Overview and Strategy[1], a document which develops and discusses the premises to EPRI's R&D plan and which contains pertinent information for the committee.

There are four major pertinent topics:

1. What is the energy growth and more specifically the electricity growth we should use as a basis for planning?

2. What are the fuels we can envision being available to meet that growth and how does coal fit into that picture?

3. What are the major environmental effects from coal-use and how much of a risk do they represent?

4. Are there technologies available now or prospectively to utilize coal in a manner consistent with our economic and environmental goals?

In evaluating these questions, EPRI has determined that it must help the industry prepare for a doubling of coal-use over the next two decades. The present pulverized coal technology will have to be the primary method of using coal. While present new units probably adequately control emissions, improvements may be necessary. Therefore, EPRI is working on better emissions control technology for such units. It is developing also two alternate technologies which should control effluents equally well or even better and perhaps do so at a lower cost.

Energy and Electricity Growth

There is only one certainty about the future: we cannot know for sure what will happen until after it has happened. EPRI's program, therefore, is structured around what is needed to be ready to anticipate the future rather than trying to build around an exact prediction of what will happen.

Moreover, energy is not an end objective in itself but rather an intermediate to produce goods and services. The basic planning objective is to assure enough energy be available so that it is not a constraint to economic growth. As a minimum planning level, EPRI chooses a "low" economic growth sufficient to merely provide goods and services to the future work force equivalent to today's standard.[2] An alternative scenario of "intermediate" economic growth is also analyzed. This is to assure that strategies sufficient for the "low" case are consistent with those of the "intermediate" case as well.

Energy requirements are derived based on models of the economy and include substantial improvements in the efficiency with which energy is used.[3] The electricity fraction of the energy demand is derived by making assumptions on relative fuel prices and technology availability and comparing the resulting outputs of several energy models.[4]

The resulting economic and energy growth is shown in Figure 1 and Figure 2.[5] These are summarized below for the period 1980 to 2000:

	Growth Rates in Average Annual Percent 1980-2000		
Growth Case	GNP	Energy	Electricity
Intermediate	2.9%	2.1%	4.2%
Low	2.5%	1.5%	3.3%

Fuels to Meet Electricity Requirements

Section D of the Overview & Strategy develops the way such electricity requirements will likely be supplied focusing on the year 2000. These are shown graphically in Figures 3 and 4[6] and tabularized in Figures 5 and 6[7] for the "intermediate" and "low"

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[1]Electric Power Research Institute, 1982-198[illegible] Overview & Strategy, Report P-2156-SR, Palo Alto, EPRI, November 1981.

[2]Op. cit., pp. 25 & 26

[3]Op. cit., pp. 18-20 and Section II-C (pp. 45-59)

[4]Op. cit., pp. 21 & 24

[5]Source op. cit., pp. 22 & 23

[6]Source op. cit., pp. 66 & 67

growth cases respectively. In addition, each case is analyzed under a "low" and "high" nuclear case.

Essentially it is found that oil, gas, and coal liquids will contribute slightly less than oil and gas did in 1980; renewables will expand substantially but still represent a small fraction of either capacity or generation; nuclear will either be limited to plants under construction or planned (the low nuclear case) or an additional 100 GW could be completed by the year 2000 (the high nuclear case). This results in coal use being called to expand to the maximum extent possible. Between 1980 and 2000 coal capacity would nearly double and coal generation would more than double.[8] Even then, all the electricity required will not be furnished under all but the low economic growth, high nuclear case.

The extent to which coal capacity can be expanded is discussed.[9] It is not the coal resource itself which is constraining but rather the rate at which the expansion can be developed. The principal constraints being time, policy decisions, competition for other uses, and prices.

This coal expansion in the electric utility industry is viewed as being supported on current coal-using technology, i.e., pulverized coal firing.[10] New improved technology, what is termed "advanced coal" technology will not play an important role until after the year 2000. This reflects the long lead time needed to develop a new technology. And even when developed it takes decades between the first order and the significant penetration of such a new technology. This is particularly true for electricity generating equipment where the lead time from first decision to build capacity and completion of construction tends to run toward a decade (see Figure 7).[11]

Environmental Risks

The combustion of coal creates effluents--gaseous, particulates, solids and thermal--which can be controlled to a certain degree by current technology. The principal concerns are the potential for effects to human health and to ecological systems. While science can never prove that no risk exists at any given level of exposure, science can establish the likelihood of an effect within a given degree of uncertainty.

[7]Source op. cit., pp. 71 & 72

[8]Op. cit., pp. 70 & 71
[9]Op. cit., pp. 78-81
[10]Op. cit., pp. 66-67
[11]Source op. cit., p. 109

As pointed out in the Overview and Strategy[12], a doubling of coal-use is likely to be accompanied with a decrease in particulate emissions, no increase in sulfur dioxide emissions, but a proportional increase in nitrogen oxides. This result comes from the replacement of older coal-fired capacity with new capacity which incorporates better particulate and sulfur oxide control capability.

While some uncertainty exists, present ambient levels of pollution in the U.S. are thought not to cause short-term deleterious effects on human health. Longer-term effects may exist, but there are substantial differences in views among experts. Similarly, direct effects on ecological systems have been controlled by reduced emissions and better diffusion of emissions. But the magnitude of indirect effects, primarily from acidic deposition, is uncertain and is being extensively researched.

The present disposal practices for solid waste--primarily ash and sludge--is generally considereed to sufficiently contain possible leachates. However, there is consideration of more stringent standards. Limits on thermal effluents for new plants are sufficiently stringent such that closed-cycle cooling is generally used. However, the question of effect of small temperature increases in receiving water systems is still being evaluated.

Control of all these effluents from coal-fired power plants are possible either by reducing their creation at the point of combustion, by removal after combustion, or containment after their creation. Zero creation or zero discharge are not feasible but substantial reductions are possible. However, each increment of reduction is increasingly expensive (see Figure 8).[13] Therefore, striking the balance between increasing electricity costs and degree of control desired is an important policy issue.

Technology for Coal-Use

The current technology for coal-use in electric power plants is pulverized coal combustion. Efficiency of the technology has been improved over the past decades such that nearly all the fuel is converted to heat energy. However, noncombustible particulates are released; sulfur contained in the fuel creates sulfur dioxide; nitrogen in the combustion air is fixed with oxygen creating nitrogen oxides; water is used for cooling to take away heat.

Particulates can be controlled by precipitators or bag filters removing well over 99% of this matter. Disposal of this "fly

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[12] Op. cit., p. 159
[13] Source op. cit., p. 163

ash" plus the nonvolatile "bottom ash" is typically done in controlled land fills such that leaching of materials is small.

Sulfur oxide can be reduced by using fuels low in sulfur or by removing the sulfur dioxide from the flue gas by scrubbing with a reacting solution. Up to around 90% can be removed by technology presently available. However, there results a sludge of sulfur oxide compounds which must be disposed as with the other solid waste.

Processes to remove the nitrogen oxides are not yet commercially available although several processes are under development. However, the formation of nitrogen oxide can be controlled by different furnace design and control of the combustion conditions. A reduction in the formation of nitrogen oxides in the order of 50% can be achieved by these means.[14]

Water is used to cool the steam used to drive the turbine. The least costly method is to use water from some natural body (e.g., river or lake) and return it slightly warmer. Because of concern about such thermal emissions, most new plants are now built with closed systems in which such water is recirculated. Man-made lakes, canals, or cooling towers are used for cooling the water before its re-use.

Two new coal-using technologies are approaching commercialization, that is, they are in various pilot plant stages now. One is the fluidized bed combustion process. In this process both the combustion conditions and the use of limestone in the combustion process reduce sulfur and nitrogen oxide emissions at least to the levels of the best pulverized control technologies of today.

The second technology involves gasification of the coal and removal of contaminants prior to combustion. To achieve comparable cost to pulverized coal technology, higher thermal efficiencies are achieved by utilizing a combined cycle: a combustion turbine combined with a heat boiler.

Summary

For EPRI's planning, the following are the answers posed at the beginning of this paper:

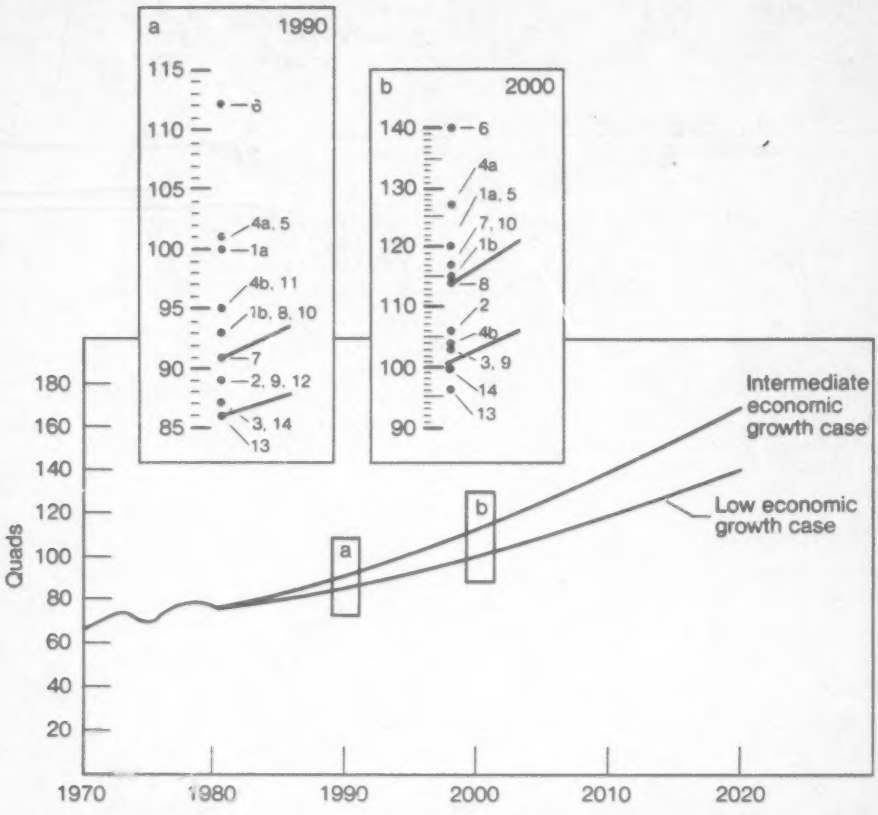
1. Energy growth is likely to continue over the next several decades and a growing fraction of this energy is likely to be furnished as electricity.

[14] Op. cit., p. 162

2. While several sources of fuels will be used to produce this electricity, coal will be a major contributor. It is likely that use of coal will double over the next two decades.

3. Environmental effluents from coal use appear to pose manageable risks although there are uncertainties as to the exact extent of the risks.

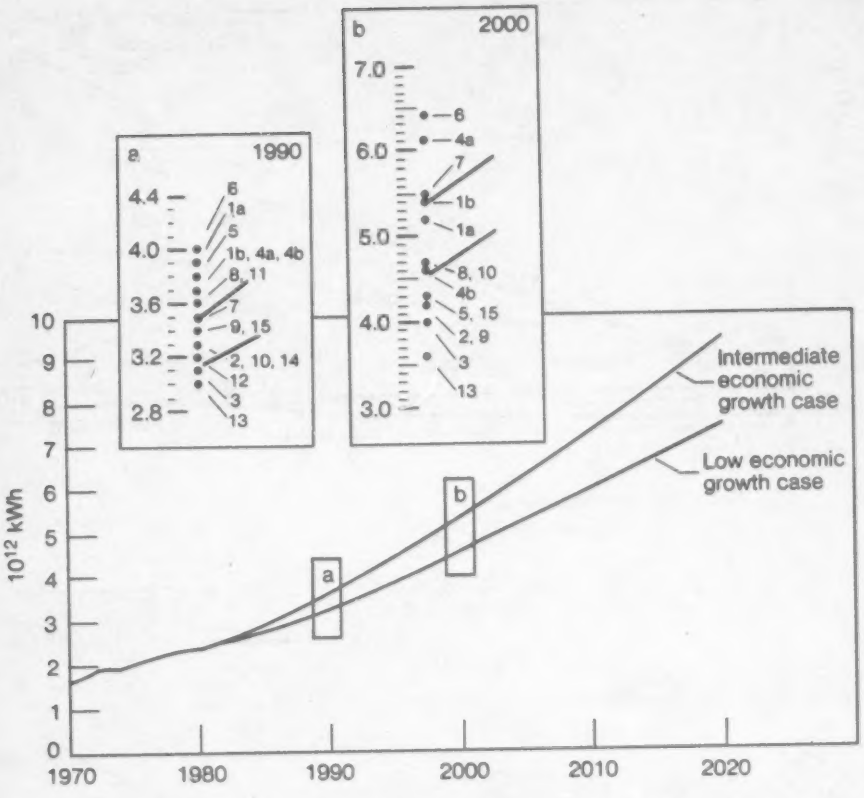
4. Technologies are now available for controlling environmental effluents from coal utilization. New technologies which may control effluents better or at lower cost will begin to be available in the next decade.



1a. PILOT-PPIM, 1981
1b. PILOT-WEM, 1981
2. EPRI Demand Baseline, 1981
3. EIA Middle Case, 1981
4a. ORNL High, 1981
4b. ORNL Low, 1981
5. CONAES III$_3$, 1980
6. Hudson-Jorgensen, 1981
7. EEI EGIF Preferred, 1980
8. General Electric, 1980
9. Westinghouse, 1981
10. General Motors, 1981
11. Bankers Trust, 1980
12. Shell, 1980
13. Exxon, 1980
14. National Energy Policy Plan, Midrange, 1981

Average Annual Energy Growth Rates			Realized Annual GNP Growth Rates		
	1980–2000	*2000–2020*		*1980–2000*	*2000–2020*
Intermediate	2.1%	1.9%	Intermediate	2.9%	2.0%
Low	1.5%	1.5%	Low	2.5%	1.7%

Figure 1 Total U.S. Primary Energy Consumption for Two Economic Growth Rates



1a. PILOT-PPIM, 1981
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2. EPRI Demand Baseline, 1981
3. EIA Middle Case, 1981
4a. ORNL High, 1981
4b. ORNL Low, 1981
5. CONAES III_3, 1980
6. Hudson-Jorgensen, 1981
7. EEI EGIF Preferred, 1980
8. General Electric, 1980
9. Westinghouse, 1981
10. General Motors, 1981
11. Bankers Trust, 1980
12. Shell, 1980
13. Exxon, 1980
14. NERC, 1981
15. National Energy Policy Plan, Midrange, 1981

Average Annual Electricity Growth Rates

	1980–2000	*2000–2020*
Intermediate	4.2%	2.8%
Low	3.3%	2.4%

Figure 2 Total U.S. Electricity Generation for Two Economic Growth Rates

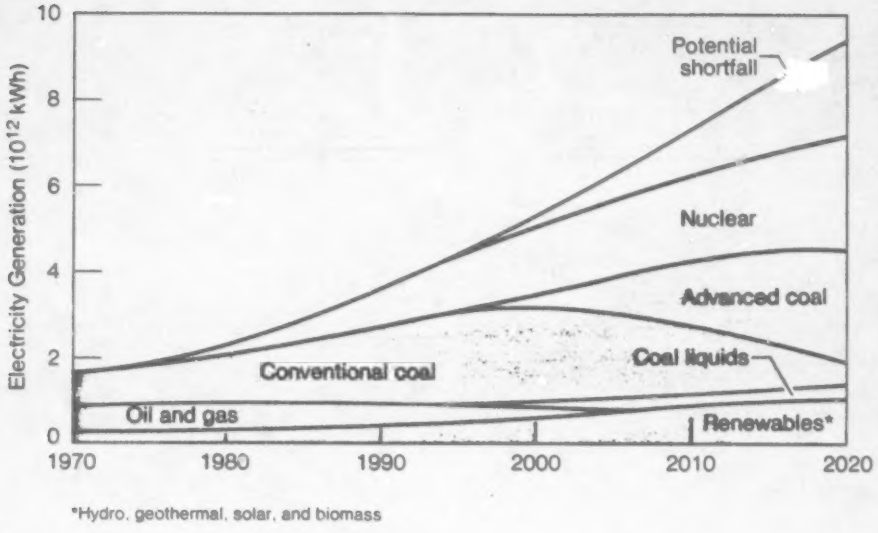


Figure D-1a. Electricity Supply 1970–2020, Intermediate Economic Growth Case, 250 GW Nuclear in Year 2000

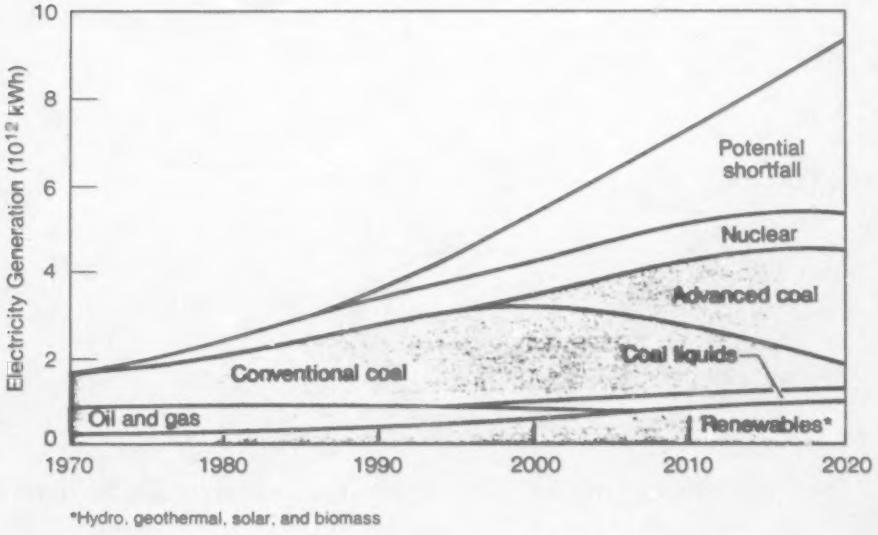
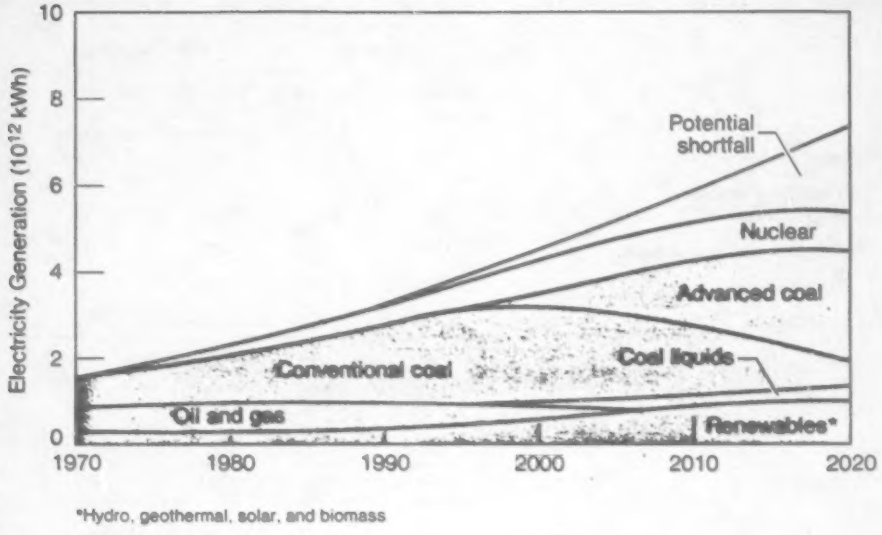
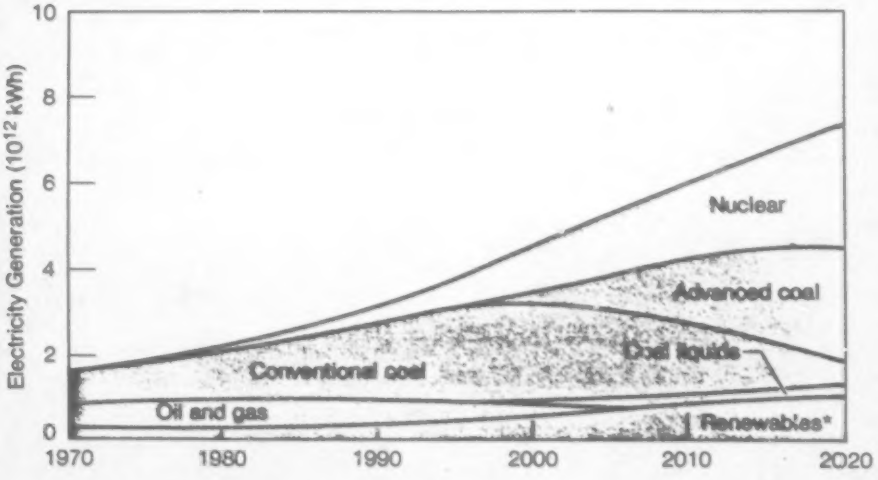


Figure 3 Electricity Supply 1970–2020, Intermediate Economic Growth Case, 150 GW Nuclear in Year 2000



*Hydro, geothermal, solar, and biomass

Figure D-2a. Electricity Supply 1970–2020, Low Economic Growth Case, 150 GW Nuclear in Year 2000



*Hydro, geothermal, solar, and biomass

Figure 4 Electricity Supply 1970–2020, Low Economic Growth Case, 250 GW Nuclear in Year 2000

	Low Nuclear		High Nuclear	
	Capacity (GW)	Generation (10^9 kWh)	Capacity (GW)	Generation (10^9 kWh)
Nuclear	150	920	250	1533
Coal-fired (conventional and advanced)	436	2406	436	2406
Oil, gas, and coal liquids	190	313	190	313
Hydro	100	420	100	420
Geothermal	16	105	16	105
Solar, wind, and biomass	10	44	10	44
Storage	36	−13	36	−13
Total supply capability[a]	938	4195	1038	4808
Shortfall	234	1195	134	582
Total requirement	1172[b]	5390	1172[b]	5390

Notes: [a]Total supply capability in 2000 includes 40 GW of industrial units.
[b]Reserve margin of 20% was used to calculate capacity values.

Year 2000 capacity factors used in all cases

Nuclear	70%
Coal direct fired	63%*
Oil, gas, and coal liquids	19%
Hydro	48%
Geothermal	75%
Solar, wind, and biomass	50%

*All baseload was assumed to have 70% capacity factor. Direct-fired coal was used for both base- and intermediate load.

Figure 5 Installed Capacity in Year 2000, Intermediate Economic Case

	Low Nuclear		High Nuclear	
	Capacity (GW)	Generation (10^9 kWh)	Capacity (GW)	Generation (10^9 kWh)
Nuclear	150	920	212	1285
Coal-fired (conventional and advanced)	436	2406	436	2406
Oil, gas, and coal liquids	190	313	190	313
Hydro	100	420	100	420
Geothermal	16	105	16	105
Solar, wind, and biomass	10	44	10	44
Storage	36	−13	36	−13
Total supply capability[a]	938	4195	1000	4560
Shortfall	62	365	0	0
Total requirement	1000[b]	4560	1000[b]	4560

Notes: [a]Total supply capability in 2000 includes 40 GW of industrial units.

[b]Reserve margin of 20% was used to calculate capacity values.

Year 2000 capacity factors used in all cases

Nuclear	70%
Coal direct fired	63%*
Oil, gas, and coal liquids	19%
Hydro	48%
Geothermal	75%
Solar, wind, and biomass	50%

*All baseload was assumed to have 70% capacity factor. Direct-fired coal was used for both base and intermediate load.

Figure 6 Installed Capacity in Year 2000, Low Economic Case

Technology	Lead Time (yr)		
	Design and Licensing	Construction	Total
Nuclear LWR (1000 MW)	5	6	11
Conventinal coal (1000 MW)	4	5	9
Gasification–combined-cycle (1000 MW)	4	3	7
Combined cycle (250 MW)	2	2	4
Wind farm (122 MW)	2	2	4
Combustion turbine (100 MW)	2	1	3
Fuel cell (30 MW)	2	1	3
Batteries (20 MW 3 hours)	2	1	3

Source: EPRI *Technical Assessment Guide*, 1981.

Figure 7 Relationship of Unit Size to Lead Time

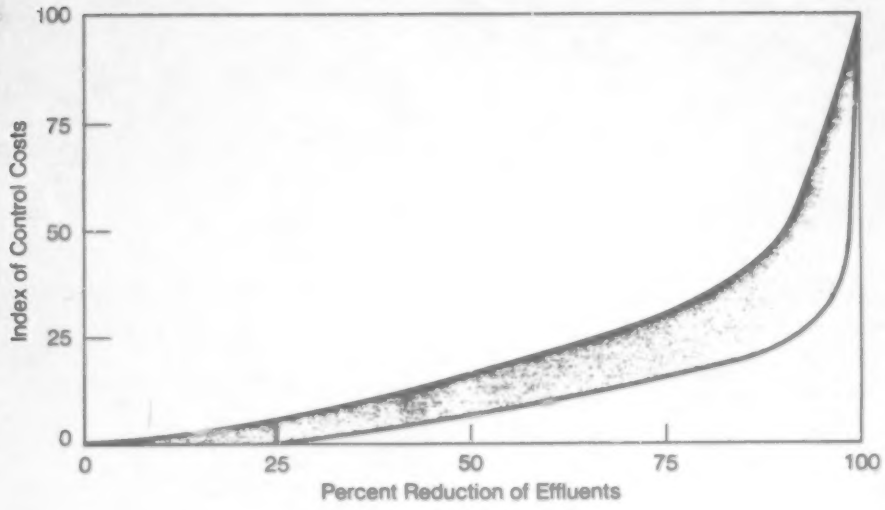


Figure 8 Total Generalized Environmental Control Costs as a Function of Effluent Control for Conventional Fossil-Fuel Power Plants